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# Local Perception of Traditional and Avocado Crops as Ecosystem Services in the Mariposa Monarch Biosphere Reserve

**Abstract:**

The concept of ecosystem services (ES) refers to the goods and services that ecosystems produce for the benefit of people, serving as generators of well-being. Three dimensions are recognized that promote the presence of these services: the material, the relational, and the subjective. These dimensions are highly influenced by the lifeworld, which has been crucial for documenting processes of environmental degradation. In this sense, it is important for geography to determine the connections between the social typifications of meaning and the spatiotemporal rhythms of action, contributing to the discovery of underlying structures of intentionality. One of the main challenges in the management of ES is their interdependence, as their relationships are often nonlinear, and there is a preference for the immediate provision of one service over others, resulting in trade-offs characterized by the reduction of productive capacity in favor of another. This study analyzed, through semi-structured surveys applied in the field, face to face, the perception that people living in the Monarch Butterfly Biosphere Reserve have regarding traditional and avocado crops, the latter characterized by promoting compensations through land use change from native forests to large monoculture areas in the State of Michoacán, which is rapidly expanding in the lower zone of the RBMM. The results show that perceptions and feelings associated with these services contrast with each other, daily life activities, means of family livelihood, and proximity to the core and buffer zone are determining factors in the perception of these ES. The results of this work, based on the geography of perception, can be useful as guiding threads for the development of effective, specific, and inclusive management and conservation plans based on the feelings, knowledge, and needs of people who are recognized as actors favoring ecosystem conservation or the creation of externalities.

**Keywords**: Ecosystem services, perception, avocado, traditional crops.

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## Introduction

The concept of ecosystem services (ES) refers to the goods and services that ecosystems produce and co-produce, both for and for the benefit of people. These services are classified into cultural, regulatory, and provisioning services (MEA, 2005; Balvanera, 2007; Palomo, 2016). Their primary function is to generate well-being for individuals, and it is crucial to recognize the multidimensionality of the concept. Consequently, ES are recognized as the result of complex socio-environmental systems' interactions, fostering processes of assigning meanings and values to elements of the natural environment and geographic space. This, in turn, bears witness to a history shaped by past and present processes. The geographic space, through the lived and perceived world, has been essential for documenting processes of natural environment degradation (Infante and Arce, 2013). Therefore, promoting participatory approaches involving stakeholders is considered crucial to incorporate social demands into decision-making processes. In recent years, inclusive, transversal, and representative approaches have been widely used in ES research (Barnaud et al., 2023; Cabrían-Piqueras and Kleyer, 2023; Jorge-García et al., 2023).

Geography of perception focuses on studying how individuals perceive their lived space and how this conception can directly influence behaviors and decision--making regarding the natural environment (Lemus and Urquía, 2018). Given the complexity of analyzing geographic space from the ES concept, it is important to facilitate the interaction of diverse geographic thought currents: quantitative and qualitative, objective and subjective, technological and human. This approach capitalizes on the epistemological richness and diversity of geographic thought currents.

One of the main challenges in ES management is the interdependence among them. The relationships between these services are often highly nonlinear, and there is a preference for the immediate provision of one service over others, resulting in compensations characterized by the decrease in the productive capacity of one service in favor of another (Heal et al., 2001), such as the expansion of agricultural frontiers leading to a decrease in forested areas. These compensations, as classified by Rodríguez et al. (2006), can be in three axes: spatial scale, temporal scale, and reversibility. Additionally, the production of one ES can, albeit less commonly, generate synergies, where one or more ES benefit from increased productivity of another (Rodríguez et al., 2006; Raudsepp-Hearne et al., 2010; Mora et al., 2016). These synergies are often directed towards regulatory and provisioning services through cultural services.

Concerning environmental pressure factors in the Mariposa Monarch Biosphere Reserve (MMBR), early warnings of extensive low-productivity agricultural frontier growth for subsistence were noted by Merino (1996). This trend

persisted during the first half of the 2000s (Brower et al., 2002; Ramírez and Zubieta, 2005). Salas-Canela (2013) identified a constant loss of primary vegetation cover from 2003 to 2012, mainly on the outskirts of the MMBR polygon, a dynamic that continues today with changes in wood extraction methods. On another note, the successive conversion of traditional-communal use natural resources into public-multiple use resources (Brenner, 2009) and conflicts arising from discrepancies between indigenous community rules (customary law), land tenure regulations, and environmental regulations governing land ownership have exacerbated various socio-environmental problems in the study area (Orozco et al., 2008).

In recent decades, there has been significant growth in avocado cultivation, particularly in states like Michoacán (SIAP, 2020), representing a source of significant economic income for those within the study area. This has displaced ancestral agricultural activities, such as maize cultivation, which serves as the basis of the reserve's diet, unlike avocados primarily destined for export.

Finally, the socio-environmental context within the MMBR is reflected in various studies, debates, reflections, or approaches to territory management, highlighting encounters and disagreements that require constant review due to historical processes evolving in diverse terms (Pérez, 2015).

Therefore, it is crucial to analyze how people residing in the MMBR perceive traditional crops and avocado cultivation as ES. Due to their ancestral methods, production requirements, beliefs, and ways of interacting with them, these perceptions may generate discordant valuations among communities. These valuations are of interest and play a crucial role in understanding the significance ecosystems hold for individuals (Farber et al., 2002). From these perceptions, strategies can be explored to create conditions or foundations for synergies in the utilization and conservation of the natural environment. Additionally, understanding the qualitative and subjective values they generate contributes significantly to the comprehensive valuation of ES, acknowledging that only at local scales can ancestral knowledge and relationships with the environment be captured within the geography of the ES concept.

Therefore, this study focused on analyzing communities' perception of traditional crops and avocado cultivation as ecosystem services within the Mariposa Monarch Biosphere Reserve. It employed interviews exploring the emotional attachment and sentiments associated with the mentioned crops, grounded in the geography of perception and critical geography. This approach aimed to answer questions such as whether aspects of daily life, ancestral customs, or monetary values assigned to traditional and avocado crops determine the allocation of non-monetary values to ES.

## Materials and Methods

### Study Area

The Mariposa Monarch Biosphere Reserve (MMBR) is located between the states of Mexico and Michoacán (Fig. 1) with an approximate extension of 57 thousand hectares spanning 10 municipalities and various ejidos. Notably, the ejidos

of Chincua, La Mesa, Cerro Prieto, and Angangueo stand out due to their location in the monarch butterfly hibernation zone.

The total population of the study area, according to INEGI data (2020), is 65,346 people, making this reserve one of the most populated in the country. As depicted in Figure 1, ejidal land tenure is distributed throughout the study area. According to the 2022 INEGI economic census, the primary economic activities in communities outside the core zone are related to retail trade, other services excluding government activities, and manufacturing industries. These activities are

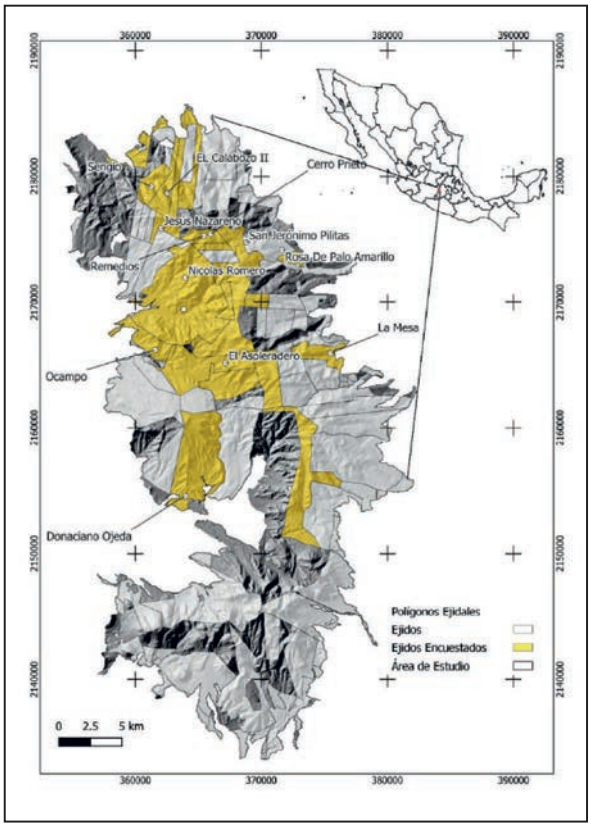



Figure 1: Location of the study area Monarch Butterfly Biosphere Reserve

less connected to the annual arrival of the monarch butterfly compared to the core zone of the reserve, where ecotourism-related activities prevail.

## Materials and Methods

### Study Area

The land use dedicated to avocado cultivation within the study area is approximately 2,332.9 hectares, as estimated for the year 2023 using Sentinel 2A satellite imagery through the segmentation process. Recognizing the challenge of assigning values due to cultivation methods in forested areas interspersed with native vegetation, the potentially agricultural parcelized area (uncovered and cultivated land) is 11,851.3 hectares.

### Selection of Ecosystem Services

The identification of ecosystem services (ES) within the MMBR was initially estimated based on available information from official data and satellite image analysis. After identifying services that could be representative based on biophysical values in the study area, a pilot survey was conducted with a group of 16 ejido leaders. Observations from the group identified negative sentiments associated with avocado cultivation, initially grouped under the „cultivation" ES. Consequently, there was a recognition of the need to separate this cultivation from traditional ones, responding to the scientific community's call for consideration and prioritization of diverse values attributed to ES by the residents of the studied spaces. This is deemed essential for these studies to be regarded as genuine strategic tools for decision-making. Perceptions, being individuals' positions on the world and ways of interacting with the environment, are crucial to evaluate based on them. This involves identifying the meaning given to the natural surroundings in everyday life, enabling the establishment of a hierarchy or prioritization accompanied by local narratives revealing underlying values. Consequently, the inclusion of multiple social actors facilitates the integration of modes of interaction and values of use and non-use assigned to ES.

### Implementation and Survey Design

The survey design was based on observations made during pilot tests, grounded in the Geography of Perception. This acknowledges that a territory's identity is the set of collective perceptions held by its inhabitants regarding their lived and perceived space. This forms the basis for decision-making regarding environmental conservation. The aim was to obtain the subjective view of individuals toward agricultural activities, emphasizing the need to capture a sufficient number of sentiments associated with these activities. The survey included positive values such as joy, peace, tranquility, inspiration, beauty, and negative values such as sadness, concern, anger, fear, anxiety, along with a neutral group including melancholy and indifference. Additional sections, labeled „others," allowed participants to add sentiments not originally included in the survey design. A table was created, presenting traditional crops and avocados on one side and the feelings they generated among people on the other. These were connected by a line, and participants could make multiple selections.

The fieldwork planning and survey application considered two main interest groups. The first group would be surveyed using the snowball technique and

face-to-face interactions in the communities of interest. This approach aimed to reach vulnerable groups whose opinions were seldom consulted or considered due to power asymmetries within the ejido and community system. A known person within the community was sought to facilitate contact with individuals facing extreme poverty, mobility issues, elderly individuals, those without ejidal titles, and women. The goal was to gather opinions through an initial conversation that, depending on the person's disposition, could lead to an interview to contextualize the survey data. The number of surveyed individuals was determined in the field using the saturation method, where the application stopped when responses became highly similar. In the second phase, the same survey was applied to individuals with ejidal roles (ejidal board and individuals with ejidal titles) during regional meetings before the arrival of the monarch butterfly.

Spatially, efforts were made to apply surveys across an extended area, covering various levels of natural environment conservation. This approach aimed to identify people's perceptions based on diverse limitations in utilizing their surroundings and various support programs to which they may be susceptible depending on their location within the reserve.

## Results

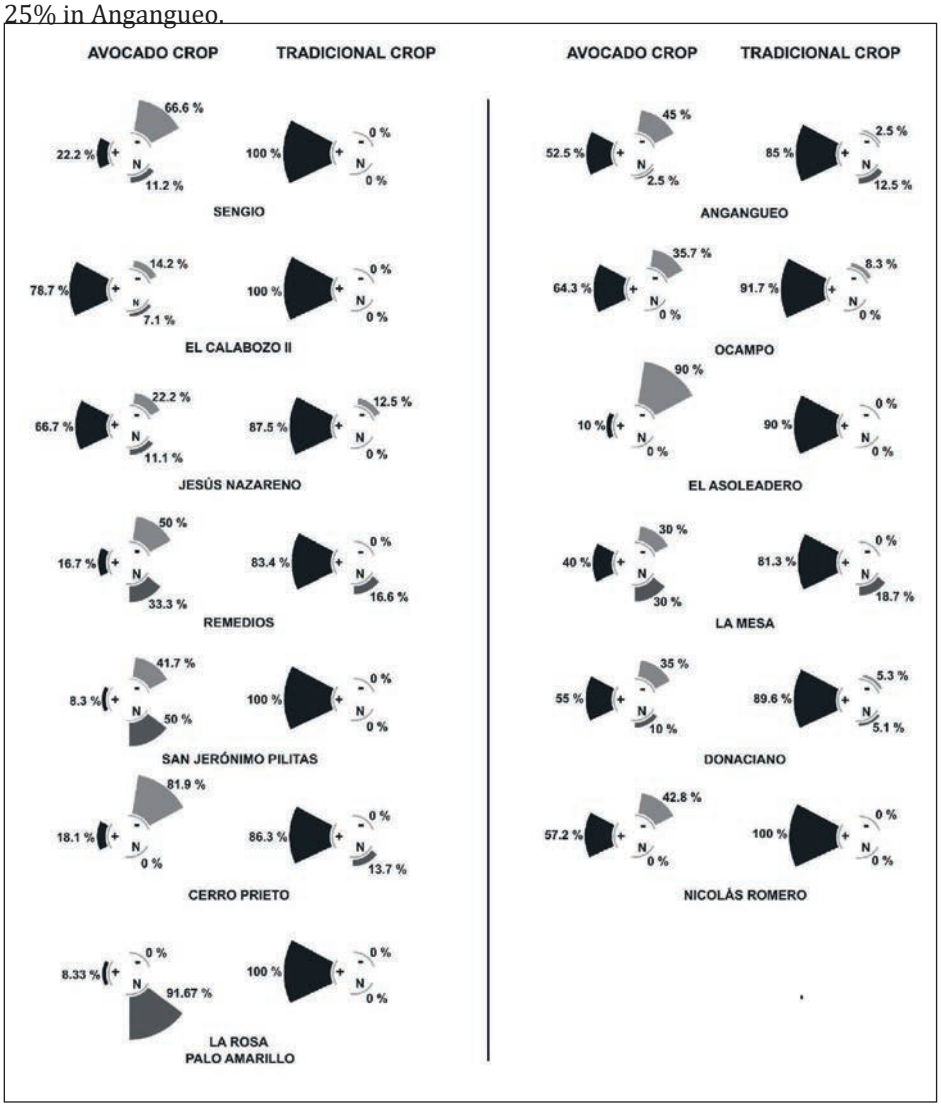
The survey application took place in September, October, and December of 2022, during which a total of 292 individuals were surveyed. Among them, 59% were women, and 41% were men, with an average age of 46.8 years. Based on their spatial location and data on annual avocado production from the Agricultural and Fisheries Information Service (SIAP), it is estimated that 23.8% of participants belong to avocado-growing areas, 38% to communities receiving significant income from ecotourism, and 38.2% to communities not significantly benefiting from these activities.

From the survey application, the following results were obtained. Positive sentiments associated with avocado cultivation stand out in the El Calabozo II community, where economic activities are based on traditional agriculture. In this community, 50% of the surveyed individuals associate the feeling of joy with avocado cultivation, 21.4% with peace, and 7.1% with tranquility. This makes it the community with the highest percentage of positive feelings assigned to avocado within the MMBR. It is important to mention that this community showed the second-lowest age dispersion, with surveyed individuals ranging from 43 to 70 years old. Following are Jesús Nazareno with 66.7% and Ocampo with 64.2% positive assignments, associating the feeling of joy with avocado cultivation. Ocampo has the shortest age range, from 15 to 18 years, as interviews in this community were conducted in high schools.

On the other hand, negative sentiments associated with and declared towards avocado show a high percentage in the El Asoleadero community with 90%, Cerro Prieto with 81.9%, and Sengio with 77.7%. In the first community, anger is the most declared sentiment, while in the latter two, sadness is the most mentioned sentiment. These results align with the predominant economic activity in these locations: ecotourism, derived from the arrival of the monarch butterfly. Lastly,

individuals from the El Asoleadero community in the state of Michoacán declared an average age of 41.2 years. In this context, communities in the State of Mexico, such as San Jerónimo Pilitas and Rosa de Palo Amarillo, which do not receive significant economic support from government programs, ecotourism, or avocado, exhibit neutral sentiments like indifference and do not declare sentiments, prevailing at 91.67% and 50%, respectively.

Assignments of sentiments to traditional crops were more homogeneous compared to avocados. These crops averaged 91.9% positive sentiments within the MMBR, with joy being the most declared sentiment during fieldwork in all communities. To obtain this average, the total number of surveys was considered. It is noteworthy that the cities of Ocampo and Angangueo declare traditional agricultural crops as elements signifying identity, assigning them 50% in Ocampo and 25% in Angangueo.



Finally, assignments of neutral sentiments for traditional crops showed low values: melancholy was assigned 18.8% in the La Mesa community, and indifference was 9.1% in Cerro Prieto. Negative sentiments towards traditional crops presented in the Jesús Nazareno community were 12.5% anxiety and 8.3% fear in the city of Ocampo.

Table 1: Type of sentiments per locality associated with traditional crops and avocado in percentage, where + refers to the percentage of positive sentiments, – to negative sentiments, and N to neutral sentiments.

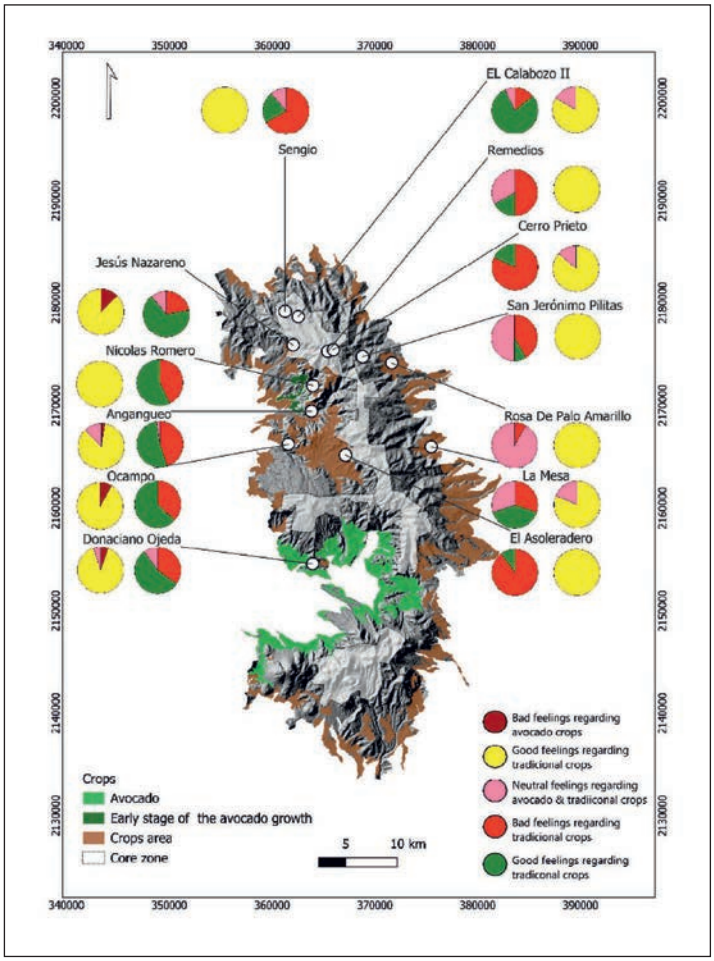



Figure 2: Distribution of feelings associated with avocado and traditional crops

In regard to the spatial behavior of people's perception of ecosystem services (ES) related to avocado cultivation and traditional crops, we can observe a correlation between the proximity and primary economic activities of communities within or near the core area of the Mariposa Monarch Biosphere Reserve (MMBR) and negative perceptions about avocado cultivation. Conversely, communities located farther from the core area, receiving fewer government supports and with economies not linked to ecotourism, attribute positive sentiments to avocado cultivation. Joy is the most frequently declared sentiment in avocado-growing areas, followed by the sentiment of tranquility. In all cases, neutral values remain at low percentages, except for the Rosa de Palo Amarillo community, which recently experienced incidents of violence. They assigned 90% of feelings of indifference to this crop through the option „does not declare." Thus, it can be acknowledged that the intensive data capture method through face-to-face interviews in the study area may be, in part, highly influenced by recent events (Fig. 2).

## Discussion

The Mariposa Monarch Biosphere Reserve (MMBR) exhibits geographic characteristics similar at a regional scale. However, at a local scale, significant changes occur, particularly in socio-organizational aspects, means of production, worldviews, ecosystem conservation status, and perceptions of ecosystem services (ES) within the study area. The proximity and exchanges between localities, along with common historical processes, have shaped modes of coexistence based on community agreements, especially in the State of Michoacán. These modes were abruptly altered by the declaration of the natural reserve.

Therefore, analyzing the assignment of sentiments to traditional crops and avocados is crucial for genuinely involving communities in environmental conservation efforts. These sentiments reflect how communities have related to, perceived, and utilized space, as well as the benefits they have derived and the trends of expansion or contraction of these ES. Individual tastes and preferences, constantly linked to well-being, are not fixed or associated, demanding periodic and prolonged studies in the study area to identify trends in ES utilization. Historical information creation is essential to analyze how these non-monetary value assignments have evolved over time and if they have been linked to other values, such as monetary ones.

For instance, field observations reveal that maize cultivation in the communities of the State of Mexico is valued for its annual supply and food autonomy, regardless of market value. Rarely is maize used for sale because the market price is not lucrative. However, if conditions for commercialization change to generate significant economic income through maize sales, the valuation of maize may shift. Therefore, creating conditions for the implementation of agrotechnologies that favor reduced impacts on ES is essential.

Importantly, considering avocado cultivation, results show a completely discordant perception among communities. Those close to avocado cultivation areas, like Donaciano Ojeda and Ocampo, as well as those in early stages of cultivation like Jesús Nazareno, El Calabozo II, and Nicolas Romero, perceive this activity more

positively. These communities see avocado cultivation as an opportunity for family economic development, leading to the trend of expanding avocado orchards at the expense of traditional crops and forested areas. Despite recognizing well-being as a multidimensional concept and natural capital as its foundation, the varying value of natural capital necessitates a socio-ecological systems approach.

Communities in the core zone of the MMBR in Michoacán, due to the scenic beauty and recognition of some biophysical benefits of the forest (expressed in interviews), prioritize environmentally friendly economic activities over others. As a result, they assign 68.4% negative sentiments to avocados, expressing concerns that such activities could endanger the continuity of their main income source (ecotourism).

On the contrary, communities in the State of Mexico, such as La Mesa, San Jerónimo Pilitas, and La Rosa Palo Amarrillo, show greater indifference toward avocado cultivation at 38.9%. This may result from their location within the MMBR, where there seems to be a disconnection from the issues faced by Michoacán communities due to the physical division between the two states and the economic activities sustaining families. Consequently, traditional crops in these communities receive 93.6% positive sentiment assignments as they are responsible for supplying the traditional food base, particularly maize. These communities also have groups, such as the Mazahuas, who attribute cultural meanings to maize, giving greater weight to ancestral lifestyles and knowledge over economic considerations.

Different approaches to environmental exploitation become extensive and intensive as some communities move away from the core zone of the reserve, making them less prone to government support reception but still obligated to contribute to environmental conservation efforts. Fieldwork and survey applications indicate lower economic inequality in communities dedicated to avocado cultivation, and this activity is recognized as responsible for higher economic income. This emphasizes the assignment of positive sentiments to avocado cultivation, with tranquility averaging 58.8% positive sentiments in benefiting communities, contrasting with 37.07% in core zone locations where ecotourism is the main activity.

Despite land-use conversion in avocado-growing communities like Donaciano Ojeda, individuals generate strategies to counteract externalities to the natural environment due to the deep-rooted sentiments and connections established with the perceived environment. This highlights the importance of people's relationships with the natural environment and ancestral knowledge as means to foster synergies within communities for environmental conservation.

In this context, acknowledging ancestry as a key factor in valuing ES is essential. The exhaustion or overexploitation of an ES can significantly impact the integrity of cultural practices and daily life. However, it is essential to recognize that market values play a role in people's assignment of non-monetary values and can serve as conduits toward environmental care. These values can be analyzed from various perspectives, enriching the theoretical, conceptual, and methodological frameworks of the topic.

## Conclusions

The chosen analysis scale when examining ES is crucial, as a local level allows the utilization of ancestral knowledge and individual relationships with the environment, aspects that may be overlooked at regional scales, risking an incomplete view of ES. In the case of the MMBR, the locality-level analysis scale reveals substantial differences in how people perceive ES. Proximity to the core zone and economic activities related to ecotourism are factors influencing the negative perceptions of avocado cultivation, particularly in the core zone.

Modes of life and aspirations are variables that, in communities like El Calabozo II, were determinants, as avocado cultivation is recognized as a sufficient means of subsistence, resulting in positive perceptions. However, in areas where avocado cultivation is in early production stages, approximately 30% of individuals assign negative perceptions due to various local and regional phenomena associated with this activity. Lastly, communities in the State of Mexico express indifference toward avocado cultivation, aligning with its limited presence. Conversely, due to the contribution of traditional crops to the well-being of people in these communities, non-monetary values assigned to them are high.

Spatial patterns of perceptions toward analyzed crops are recognized, but intrinsic spatial location is not a determining factor. Additionally, people's perceptions can vary throughout the year based on geographical phenomena present at a given time. These may include physical phenomena like erosion, hydro-meteorological events such as droughts or frosts, physical barriers like hills, rivers, and mountains, or situations related to security, well-being, and spirituality. Therefore, geographical fieldwork should be continuous, involving extended stays to capture a wealth of information across different temporalities.

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