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Interdisciplinary Faculty of Economic and Administrative Sciencies

INVESTIGATION

Social willingness to participate in environmental protection programs: the case of the Sonora River region

Disposición social a participar en programas de protección ambiental: el caso de la región del río Sonora

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Summary

This study explores the willingness to participate in environmental conservation programs among communities in the Sonora River region of Mexico. The research is justified by the historical overexploitation of natural resources and ecological disasters in the area, such as the one that occurred in 2014. The objective is to measure the likelihood of social participation, identifying the factors that drive or limit it. Logistic regression was used to analyze data from a survey applied to a random and stratified sample of 366 people. The survey, conducted between November 2022 and August 2023, collected information on sociodemographic and productive variables, and the perception of environmental services. The results show a positive and significant relationship between the willingness to participate and the perception of environmental services. Sociodemographic characteristics were found to influence participation. Specifically, women are twice as likely to participate compared to men. In contrast, occupation has a negative effect on the likelihood of participation. In conclusion, the perception of environmental benefits and gender differences are key factors in promoting greater community participation in conservation in the Sonora River.

Keywords: regional development; environmental conservation; social participation; Sonora River.

JEL codes : R50, Q38, Q51, Q58

Abstract

This study explores the willingness to participate in environmental conservation programs among communities in the Sonora River region, Mexico. The research is justified by the historical overexploitation of natural resources and ecological disasters in the area, such as the one that occurred in 2014. The objective is to measure the likelihood of social participation, identifying the factors that drive or limit it. Logistic regression was used to analyze data from a survey administered to a random, stratified sample of 366 people. The survey, conducted between November 2022 and August 2023, collected information on sociodemographic and productive variables, and the perception of environmental services. The results show a positive and significant relationship between the willingness to participate and the perception of environmental services. Sociodemographic characteristics were found to influence participation. Specifically, women are twice as likely to participate compared to men. In contrast, occupation has a negative effect on the likelihood of participation. In conclusion, the perception of environmental benefits and gender differences are key factors in promoting greater community participation in conservation on the Sonora River.

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Introduction

Today, civic engagement is increasingly relevant, both in rural and urban areas. Citizens understand the importance of assuming public responsibilities, participating in decision-making, and collaborating with collective initiatives, including those of the State. This participation has opened new paths and transformed the way politics is exercised, understanding it as the integration of individuals and groups in the definition of collective issues (Velásquez and González, 2003).

In this context, A clear example of the challenges that citizen participation seeks to resolve is found in the Sonora River region, which, despite its mineral wealth, it has suffered the consequences of mining activity. Severe contamination by heavy metals and toxic chemicals, evidenced by the 2014 environmental disaster, caused serious damage to the health of residents and ecosystems (Toscana and Hernández, 2017).

This event not only affected water security, local agriculture, and livestock farming, but also generated conflict and social dislocation. These problems underscore the urgent need for an active and engaged citizenry to protect the environment and ensure community well-being (Orozco and Rodríguez, 2022; Castro and Rodríguez, 2020).

The latter requires integrating perceptions with the contexts that shape them; however, there is little information on the relationship between such attitudes and demographic, social, and economic variables in the Sonora River communities, which restricts the development of strategies in this direction.

Therefore, this is a quantitative study that immerses us in the social reality of the Sonora River region, exploring citizens' willingness to participate in environmental conservation programs among its communities. The research is justified by the historical overexploitation of natural resources and ecological disasters in the area, such as the one that occurred in 2014 (Toscana and Hernández, 2017). Orozco and Rodríguez, 2022).

Therefore, the objective is to measure the likelihood of social participation, identifying the factors that drive or limit it. Logistic regression was used to analyze data from a survey applied to a random and stratified sample of 366 people. The survey, conducted between November 2022 and August 2023, collected information on sociodemographic variables and the perception of environmental services. The study area corresponded to the municipalities of Aconchi , Arizpe, Banamichi , Baviácora , Cananea, Huépac , San Felipe de Jesús, and Ures. All of them group a total of 59,678 inhabitants; and most of these live in municipal seats that have the same name as their municipalities.

Literature Review

2.1. Social participation in environmental protection

From an economic perspective, the characteristics of public goods can be applied to explain environmental overexploitation, degradation, and pollution. This, in theory, necessitates state intervention, regulation, and the assignment of property rights that lead people to care for and efficiently use environmental goods. However, although public policies and laws have been created in this direction, the state apparatus struggles to verify their compliance or ends up with contrary results. In this regard, vertical planning is criticized for its lack of effectiveness and time lag (Montes, 2001); or, in some cases, government policy, whether statist or privatizing, can accelerate environmental destruction (Ostrom, 2000).

In Mexico, there are certain limitations in terms of capacity and resources for environmental care in different cases; for example, the number of inspectors at the Federal Attorney for Environmental Protection [PROFEPA] was reduced from 489 to 432 between 2018 and 2022 (Méndez 2022). For her part, Sandra López of the Mexican Institute for Competitiveness [IMCO] pointed out the difficulties that Conagua faces in meeting its objectives without the budget that the commission requires for infrastructure maintenance and surveillance activities, also highlighting that the least monitored operations are those destined for mining and agriculture (Arratibel; 2023). Likewise, the National Forestry Commission [Conafor] recognizes problems such as "corruption, insufficient inspection and surveillance," as well as other problems that cause the illegal extraction of forest resources in Mexico (Conafor ; 2023:11).

Given the above, the experience of linking communities and society in the care of natural

resources becomes imperative for the following reasons. First, environmental monitoring experiences with community or citizen participation in obtaining important, high-quality information have allowed for their integration into water quality management plans (Rodríguez et al., 2024) or for territorial planning (Montes, 2001). A second aspect is that, by integrating communities into collective environmental management entities, they can be able to detect environmental problems in a timely manner, such as illegal extraction, pests, or fires (Merino and Segura, 2016). In addition, a third element is the improved conservation of natural areas with the help of communities (Maldonado et al., 2020). And finally, communities are the closest to the source of environmental problems and are the ones who suffer them most intensely.

Thus, programs or policies with a broad base of social or community support are more successful; moreover, it is not about replacing the state in its respective obligations, but rather about providing communities and society with the tools and information to protect and demand their rights (Briceño and Ávila, 2014). Thus, it is necessary to understand the extent to which this exists or a willingness for social participation exists in order to build public policy with the help of society and communities.

2.2 Analysis of the motivations for participation in environmental programs

Willingness to participate in environmental programs is a topic commonly studied using qualitative or limited response regression models. These models are used to predict the probability of an event or category occurring, rather than a continuous numerical value; in other words, they aim to determine the probability that a person will accept or refuse to participate, based on the influence of explanatory variables such as age, sex, income, educational level, and other sociodemographic and family characteristics.

In other works, it has been analyzed in different population approaches, such as producers in primary activities, where an additional factor is the characteristics of their respective productive units (Muñoz et al. 2025; Le Gloux et al., 2024; Ma et al., 2012; Vanslembruck , et al., 2002).

Furthermore, the literature identifies determinants that speak to the relationship between perception of environmental services and attitudes with the willingness to participate. Thus, some studies relate not only the sociodemographic context, but also the characteristics of rural productive units, attitudes toward conservation, and perceptions of ecosystem services with the willingness to participate (Ma, Swinton, Lupi , & Jolejole-Foreman , 2012; Thornton & Quinn, 2010; Villamagua , 2017; Zhu, Guan, & Wei, 2016).

To understand citizens' willingness to participate in environmental protection programs, it is crucial to analyze environmental attitudes. This field of study explores people's perceptions, feelings, and opinions about the environment, and how these factors influence their behavior. It seeks to understand the psychological and social factors that shape environmental awareness and the willingness to protect natural resources, especially in the face of ecological challenges (Fernández, 2008).

2.3 The importance of ecosystem services

The emergence of environmental problems can be addressed from two theoretical perspectives. The first is environmental economics, which proposes that the open nature of natural resources makes it difficult to assign a price that leads to their rational use; therefore, people have no incentive to use them efficiently. The second, again, relates to their condition, where it is observed that it is either impossible or very difficult to apply property rights that hold individuals responsible for their care (Azqueta et al., 2007). The other theoretical approach is ecological economics, which proposes a third problem, arising from an anthropocentric vision that has forgotten that the economic and social system is wrapped within the natural system; such that the first two fail to adequately distinguish the inputs and outputs of information and energy within balanced frameworks that allow for a sustainable relationship with the environment (Martínez and Roca, 2016) . Despite their differences, both make efforts to ensure that people perceive the benefits that nature provides to different human activities.

Thus, according to Constanza and Daily (1992), nature, its functions, and its components provide a flow of goods that directly or indirectly help satisfy human needs; this is a natural income. An example would be the pollination activity carried out by many birds, insects, and mammals when they search for food among the flowers of plants. This activity is beneficial because it allows for

the production of harvests and crops; otherwise, the cost of agriculture would rise. Similarly, some functions and components of ecosystems can be considered natural capital due to their capacity to generate benefits.

Although there are many approaches to addressing this, such as those proposed by Constanza et al. (1997); De Groot et al. (2002); Wallace (2007), one of the most influential is the one proposed by Millenium Ecosystem Assesstmen [MA] (2005), which conceptualizes these as the benefits that people obtain from ecosystems; and where ecosystem services are categorized into four types: provisioning services, regulating services, cultural services, and supporting services. Table 1 shows the specific benefits that each of the services provides to people.

2.4 Context of the study area

The study area corresponded to the municipalities of Aconchi , Arizpe, Banamichi , Baviácora , Cananea, Huépac , San Felipe de Jesús, and Ures. All of them group a total of 59,678 inhabitants; and most of these live in the municipal capitals that have the same name as their municipalities. In relation to the physical and environmental context, in relation to the physiography, the municipality of Ures is located in the region of the central plains, while the municipalities of Aconchi , Arízpe , Banámichi , Baviácora , Cananea, Huépac and San Felipe de Jesús are located in the area of the Sierra Madre Occidental; but part of Cananea also extends into the plains and dunes of the north , according to the National Institute of Statistics and Geography [INGEI] (2000). Climatic conditions in the study area range from dry climates in Ures to semi-dry temperate and cold climates in the other municipalities. The rainy season occurs in the summer, although it also occurs in the winter (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT] 2013; Vega et al., 2011). Vegetation is varied and ranges from oak forests to natural grassland in Cananea and parts of Arizpe; but also scrublands and mosqueles, the latter two being more representative in the other municipalities. This vegetative variety also allows for a significant presence of endemic and migratory animals of different species, including mammals, reptiles, and birds (SEMARNAT et al. 2013; Salido et al. 2009). the location of protected areas such as the National Forest Reserve and Wildlife Refuge "Ajos Bavispe", the Sierra de Mazatán and the Cañada de Mazocahui (Salido et al. 2009).

The Sonora River is the main tributary of the basin, which rises in the Arballo waterhole in the municipality of Cananea, and among its main tributaries are the Bacoachi Rivers (municipality of Bacoachi) and Bacanuchi (in Arizpe). It travels a total of 421 kilometers, passing through the Rodolfo Félix Valdez dam, El Molinito (in Ures) and even the Abelardo L. Rodríguez dam in Hermosillo. Its average annual runoff is 408 million m^2 (Luque et al. 2019; Diaz et al. 2018). Likewise, according to Conagua (2013) it indicates changes in flow, from perennial in the years 1960 to 1995, to ephemeral from 1995 to 2015; and also change in runoff from 134 hm^3 to 34 hm^3, respectively (See image no. 1).

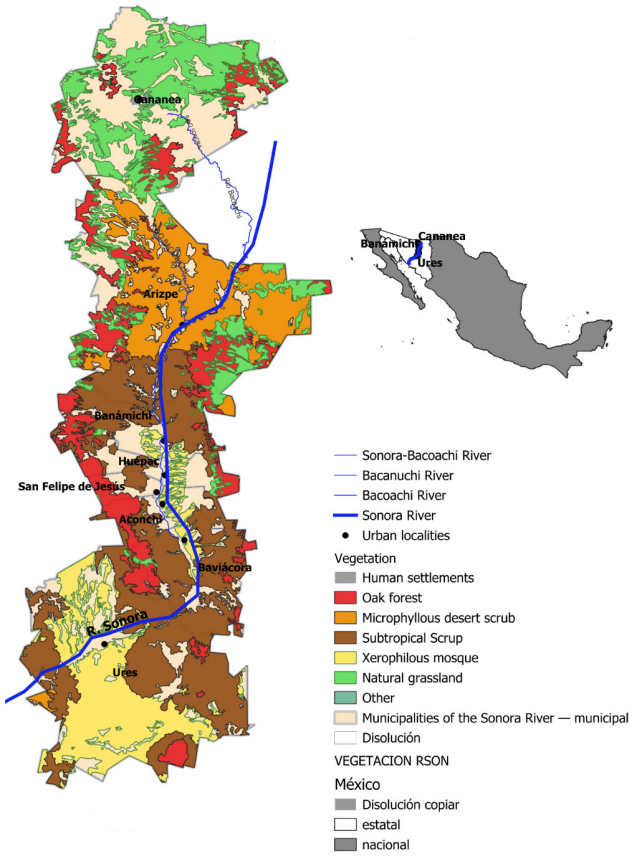
Likewise, the environmental context of the Sonora River presents significant challenges and problems, such as water pollution from mining and primary activities; the presence of trash in waterways, roads, and land; as well as overgrazing and deforestation (Salido et al., 2009).

Table 1. Classification of ecosystem services according to Millenium Environmental Assessment (2005)

Provisioning services:	Regulation services:	Cultural services:
Food and fiber;	Maintaining air quality;	Cultural diversity;
Fuels;	Climate regulation;	Spiritual and religious values;
Genetic resources;	Water regulation;	Educational values;
Biochemists, natural medicine and pharmaceuticals;	Erosion control;	Aesthetic values;
Ornamental resources; Fresh water	Water purification and waste treatment; Regulation of human diseases; Biological control;	Social relations; Sense of place; Cultural heritage;
	Pollination;	Recreation and ecotourism
	Storm protection;	
Support services The services necessary for the production of all other ecosystem services		
Soil formation	Nutrient cycle	Primary production

Source: prepared from MA (2005).

Image 1. Municipalities of the Sonora River, vegetation and main tributary



Source: prepared by the authors using data from CONABIO (2025) and INEGI (2022a)

According to INEGI data (2020), the population of the Sonora River region was 59,678 inhabitants in 2020. The gender composition shows a majority of men (50.5%) compared to women (49.5%), a general characteristic in all municipalities except Cananea, where women are the majority. Regarding employment, the population aged 12 and over is divided as follows: 54% are non-economically active population (PNEA) and 46% are economically active population (EAP). In this regard, the majority of this population specializes in service activities, although in municipalities such as Arizpe and Ures, primary activities predominate (See Table 2).

The history of the Sonora River region dates back to the settlements of the Opata people, who farmed along its banks; they also readily welcomed incursions by the Jesuits; who, building upon the communities the Opata had established along the Sonora River, established the missions of Ures, Baviácora , Aconchi , Huépac , Banamichi , and Arizpe (Camou , 1998). These communities evolved to include not only agriculture but also livestock raising. Later, In the late 19th and early 20th centuries, the mining boom in Cananea boosted the local economy.

This growth led to self-sufficiency in the Sonora River communities, even supplying Cananea and Hermosillo with products such as meat, leather, milk, and textiles. This growth also fostered the establishment of manufacturing activities, such as carpentry in Aconchi . However, the development of communication routes and the increase in imports led to a gradual decline in the area's economic dynamism (Chávez, 1987).

Currently, the Sonora River region is based on a combination of primary activities, such as livestock and agriculture, and others such as mining, commerce, and services (e.g. , recreational and tourism). Therefore, the natural resources exploited in the region correspond to soils along the riverbanks, where agricultural activities are carried out. Furthermore, grazing livestock is practiced in the mountains, a historical practice since the arrival of the Jesuits who introduced livestock to this region (Chávez, 1987). As will be seen later, subsoil resources are also exploited, as the area has significant mineral wealth. Likewise, regarding the use of water resources in aquifers and on the surface, the former is overexploited, and the latter is under full utilization (Pineda et al. 2014; Vega et al. 2011).

Primary activities, such as livestock and agriculture, are viable thanks to the river's tributary. Much of the agricultural production is used as fodder for cattle, which have adapted well to the area and take advantage of the wild vegetation as a grazing land (Castro, 2020; Castro and Rodríguez, 2020). Furthermore, the geothermal conditions in municipalities such as Aconchi and Banamichi allow for the use of hot springs, thereby motivating recreational and tourist activities that attract visitors from other municipalities in Sonora or the country (Salido et al. 2009).

It is also important to mention that this region is home to Grupo México's Buenavista del Cobre (Cananea) operating mines, with one of the largest copper deposits in the world (Toscana and Hernández, 2017); First Magestic Silver Inc.; as well as SilverCrest Inc. 's Las Chispas project (Arizpe) (Robles and Romero, 2022). In addition, mining exploration activities are underway along the Sonora River basin.

Table 2. Sociodemographic characteristics of the municipalities of the Sonora River

	Total population				Population aged 12 and over		
		%	Men	Women	Total	PNEA	PEA
Total	59,678	100	50.5	49.5	47,727	54.0	45.7
Aconchi	2,563	4.3	52.1	47.9	2,109	48.9	50.9
Arizpe	2,788	4.7	51.9	48.1	2,315	49.0	50.6
Banamichi	1,825	3.1	50.6	49.4	1,474	52.0	47.3
Baviácora	3,191	5.3	52.1	47.9	2,673	43.9	55.4
Canaanite	39,451	66.1	49.7	50.3	30,811	55.6	44.2
Huepac	943	1.6	52.4	47.6	787	39.6	60.2
Saint Philip of Jesus	369	0.6	54.5	45.5	287	51.6	48.4
Ures	8,548	14.3	52.1	47.9	7,271	55.9	43.8
	Employed population by sector of activity						
	Total	Primary	Secondary	Construction	Trade	Services	NE
Aconchi	987	24.9	24.7	5.5	17.8	26.0	1.0
Arizpe	1,084	43.1	17.1	5.5	9.9	23.9	0.6
Banamichi	748	22.5	27.5	8.2	8.2	32.9	0.8
Baviácora	1,010	25.1	18.5	11.1	15.6	29.1	0.5
Canaanite	15,481	4.0	31.4	8.2	17.6	37.3	1.5
Huepac	304	24.0	21.4	10.9	6.9	36.8	0.0
Saint Philip of Jesus	146	28.1	16.4	10.3	4.1	41.1	0.0
Ures	3,656	32.8	13.3	6.0	16.4	30.6	1.0

Source: INEGI. 2020a. Basic Questionnaire. /Primary: Agriculture, livestock, forestry, fishing, and hunting; / Secondary: Mining, manufacturing, electricity, and water; /Services: Transportation, communication, professional, financial, social, government, and other services; Unspecified

The presence of mining has not been exempt from criticism and controversy, which greatly complicates the political context in the area. To begin with, Cananea is the birthplace of the Mexican Revolution with the 1906 strike, which was suppressed by Mexican federal forces and Rangers sent from the United States of America. This is also because the political movement of Section 65 of the National Union of Mining, Metallurgical, and Related Workers of the Mexican Republic is located here; the union has been active since July 30, 2007, and its contracts were terminated on June 10, 2010, based on Grupo México's argument that the facilities were unusable (Toscana and Hernández, 2017).

Furthermore, the spill of acidified copper leachate into the Tinajas stream and from there into the Bacanuchi River , a tributary of the Sonora River, on August 6, 2014, contributes to this complexity (Toscana and Hernández, 2017; Ibarra and Moreno, 2017), an event named by the head of the Ministry of Environment and Natural Resources in 2014 as the worst environmental disaster in the history of Mexico (Enciso, 2014). All of this raised concerns and criticism of the mining industry due to the perception of risks to the environment, health, and economic activities in the area (Orozco and Rodríguez, 2022); as well as specifically to water contamination and dissatisfaction with the pending objectives as part of the remediation measures and social, economic, and health care for the communities of the Sonora River (Haro and Salazar, 2021).

To address this problem, the Sonora River Trust was proposed, with the goal of remedying and compensating for damage to the environment and the population, respectively. It was funded with 2 billion pesos contributed by Grupo México and retained by Nacional Financiera. However, the fund only spent around 1.2 billion pesos, while several of its objectives were not achieved (Ibarra and Moreno, 2017). The situation arising from the emergency sparked distrust and, consequently, mobilizations demanding information, improved river cleanup, and preventing the opening of wells reopened by the authorities. This fund also sought to meet pending objectives (Haro and Salazar, 2021). which

to this day, eleven years after the spill, have not been fully complied with, despite the recognition of the right to environmental reparation by the Supreme Court of Justice of Mexico (Gómez, 2025), given the extinction of the Sonora River Trust that occurred on February 7, 2017 (Haro and Salazar, 2021).

Therefore, there is a struggle over water between local residents and extractive activities, which reinforces distrust of the benefits that mining can bring (Toscana and Hernández, 2017). Likewise, recently, demonstrations and protests by local residents and citizens of Hermosillo were observed following the announcement by the Sonora government of the 2023-2053 Sonora Water Plan, which proposes the construction of three dams: two on the Sonora River, one in the town of Sinoquipe (Arizpe) and the other in Puerta del Sol (Ures) (Benítez 2025; Reyes 2025).

Therefore, independent community organization can be an alternative for the environmental monitoring and protection so desperately needed in the complex economic, political, and social context of the area; a situation that this paper explores as a possibility for alleviating the area's environmental problems.

Methodology

3.1 Materials and Methods

The survey was conducted between November 2022 and August 2023. In 2020, this population totaled 59,678 inhabitants. From a sample of 41,462 people aged 18 and over, a sample of 381 was selected (95% confidence level and 0.5% error), using a stratified random sample. Table 3 shows the number of surveys conducted in each municipality. A total of 366 surveys were ultimately conducted .

The questionnaire consisted of an informant identification section, containing their sociodemographic characteristics; a subsequent section on the perception of environmental goods; and finally, a section on willingness to participate. The section on the perception of ecosystem services (see Table 4) included:

Results and discussion

4.1 Ecosystem services perception index

A principal component analysis (PCA) was performed to synthesize information from the different dimensions of ecosystem services. The suitability of the data for analysis was confirmed with Bartlett's test of sphericity. Bartlett (χ 2 (55) =400.161, p<0.001) and the Kaiser-Meyer- Olkin (KMO) sampling adequacy measure of 0.654, both results exceeding the thresholds recommended for the analysis (Pérez 2004).

Subsequently, each of the scores obtained from the first factor for each of the records was grouped into four levels, which are conceptualized as shown in the table. The PCA identified a principal component that captured most of the total variance in the data. This component was used to generate an indicator representing ecosystem perception. The individual scores for this component were classified into four levels, as detailed in Table 5,

Table 3. Total population and population aged 18 and over in the Sonora River, 2020

	Total population	Percentage	Population aged 18 and over	Percentage	Proposed sample	Sample collected
Total, municipal	59,678	100	41,462	100	381	366
Aconchi	2,563	4.3	1,838	4.4	17	21
Arizpe	2,788	4.7	2,046	4.9	19	20
Banamichi	1,825	3.1	1,278	3.1	12	18
Baviacora	3,191	5.3	2,311	5.6	21	27
Canaanite	39,451	66.1	26,592	64.1	244	203
Huepac	943	1.6	690	1.7	6	10
Saint Philip of Jesus	369	0.6	262	0.6	2	3
Ures	8,548	14.3	6,445	15.5	59	64

Source : Prepared by the authors using data from INEGI(2020a)

Table 4. Survey variables and descriptors

Variable	Description	Unit of measurement
DAPP	Willingness to participate	1 = Yes or 0 = No
Age	Age	Years completed
Sex	Sex	1 = Female, 0 = Male
Esc	Schooling according to educational level	0= No studies 1= Primary 2= Secondary 3= Prep 4= University
Busy	He was self-employed or employed, or he was looking for work.	1 = Yes or 0 = No
Income	Family monthly income	In Pesos
Eat	Wild foods are important to the community	1= Disagree; 2= little agreement; 3= More or less agree; 4= Strongly agree; 5= Totally agree
FIREWOOD	Firewood is important for the community	
MEDI	Medicinal plants are important for the community	
LUG_REG	Religious places are important to the community	
TOURISM	Tourist/recreational places are important for the community	
EROSION	Field vegetation prevents soil erosion	
RETAIN	Vegetation helps retain water in the soil	
AIR	Vegetation in the countryside helps clean the air	
RAIN	Vegetation attracts rain	
CLIMATE	Vegetation helps improve the climate	

Source: Prepared by the authors using data from INEGI(2020a)

4.2 Logistic regression analysis

When comparing model zero with models 1, 2, and 3, it is concluded that the overall fit of the model is acceptable, considering the reduction in the -2LL for models 1, 2, and 3; and the chi-square, which is significant in all three models (Field, 2009). It should be mentioned that the explanatory capacity of all models is poor, since, according to Cox and Snell's r^2, only approximately eleven percent of the data would be predicted; although the Hosmer-Lemeshow test indicates, according to the probability associated with the chi-square statistic, that the variables do contribute to the model. However, given that this is an exploratory study, and quoting Gujarati and Porter (2010:563): "In models with binary regressors, goodness of fit is of secondary importance. What is of interest are the expected signs of the regression coefficients and their practical and/or statistical significance" (See table no. 6).

Table 5. Levels of perception of ecosystem services

	Media	Mediana	Máximo	Mínimo	Recuento
Zero or very low (0)	-1.42592	-1.34047	-0.78711	-3.10388	92
Low (1)	-0.12543	-0.22443	0.18052	-0.7869	97
Medium (2)	0.56144	0.72739	0.77254	0.19493	105
High (3)	1.17221	1.24098	1.24098	0.79066	72

Source: own elaboration
Note: Median: 0.1850200; Mode: 1.24098, Minimum: -3.10388, Q 25 : -0.7871068 Q 75 : 0.7725412; Maximum: 1.24098

Table 6. Goodness of fit of the models

Model		R^2 de Cox y Snell	-2ll	Ji^2	gl	Next.	Hosmer y Lemeshow		
Modelo 0	Just constant		432.038				Ji^2	gl	Sig
Modelo 1	Paso 1	0.114	393.027	39.011	6	0	5.18	8	0.738
Modelo 2	Paso 2	0.114	393.056	38.982	5	0	3.513	8	0.898
Modelo 3	Paso 3	0.113	393.445	38.593	4	0	4.146	8	0.844

Source: own elaboration

The analysis in SPSS vr25 yielded three models (steps). In model one, the variables age and family income level were found to be insignificant. For model two, the variable age, which had the highest standard error in model 1, was eliminated; and in this second model, the variable family income level was again insignificant. Finally, in model three, only the statistically significant variables remain; this will be the model used to describe and discuss the results.

Therefore, at least for this work, in the case of the variables age and family income, the null hypothesis cannot be rejected ($H_0: \beta = 0$). In the case of the age variable, the literature has not revealed a clear trend regarding its effects on the willingness to participate. And in this same sense, for this work, age turned out to be positive, although not statistically significant; a result that has also been observed by Zhu et al. (2016) and Wilcox et al. (2012). However, other authors have identified a negative relationship (Ma and Coppoc , 2012; Wossink and Van Wenun , 2003; Vanslembruck et al., 2002). Despite this, the effect of age, or of the generational cohort, should not be ruled out as a factor for participating in environmental management programs (Maleknia , et al.,2025).

The income variable also shows inconclusive results. On the one hand, other studies also report a significant and positive relationship between family income and willingness to participate (Chaves, 2008; Ángel Pérez et al., 2006). In other studies, López et al. (2020) observed a negative relationship. Based on a willingness to participate index obtained by principal components analysis and using stepwise linear regression, they indicate a negative relationship between income and willingness. Likewise, Zhu et al. (2016) also found this negative and significant relationship.

However, there are other analyses where a lack of significance is observed between both variables. For example, Akram and Olmstead (2011) through a probit model applied to the willingness to pay for the improvement of drinking water services, find a significant relationship, but with a parameter equal to zero, which technically reflects a null relationship. On the other hand, Barrantes and Flores (2013) show a series of econometric exercises of the logit model, and mention a positive relationship between the willingness to pay, but in their descriptive tables a relationship is observed that is not statistically significant. Likewise, Tavárez et al. (2023) also report the non-significance and explain that this result is the product of strategic behavior, because the respondent hides information or simply values projects with higher profits. In this same sense, Herrera, Delgadillo, Jaimes and Ramírez (2019) pointed out that, when conducting their survey for a contingent assessment, there were 152 people who preferred not to answer the question out of a total of 172 respondents.

Table 7. Model parameters

Variables	Model 1				Model 2				Model 3			
	B	Standard error	Wald	OR	B	Standard error	Wald	OR	B	Standard error	Wald	OR
SEX (1)	0.765	0.261**	8.610	2.149	0.763	0.261**	8.582	2.146	0.779	0.26**	9.007	2.180
AGE	0.002	0.010	0.029	1.002								
Educational level (1)	0.708	0.398*	3.174	2.031	0.688	0.378*	3.304	1.990	0.641	0.37*	3.005	1.899
Busy (1)	-0.712	0.326**	4.760	0.491	-0.710	0.326**	4.736	0.492	-0.734	0.324**	5.130	0.480
Income level (1)	-0.153	0.258	0.351	0.858	-0.159	0.255	0.390	0.853				
NVPSE	0.343	0.118**	8.372	1.409	0.346	0.117**	8.687	1.413	0.356	0.116**	9.400	1.427
Constant	-0.390	0.690	0.320	0.677	-0.307	0.485	0.400	0.736	-0.339	0.482	0.495	0.712

Source: own elaboration
Note:*/ statistically significant at 0.1; **/ statistically significant at 0.05; *** statistically significant at 0.001

This does not necessarily mean a problem, since, as Wilcox et al. (2012) point out, an alternative reading would be that age and family income were not variables that influenced the willingness to participate.

The occupation variable (EMPLOYED) indicates individuals who were paid workers in their own businesses or for an employer and were seeking employment; and individuals who performed activities other than paid work (only studying, only household activities, only retirees and pensioners). In the first case, it was coded as one, and in the second, as zero. Model three revealed a negative and statistically significant relationship between being employed and willingness to participate; thus, being employed, according to the odds ratio (OR) below one, indicates that an employed person is very likely to refuse to participate in the program.

Other studies have found that willingness to participate in environmental programs was also negatively related to the possibility of forgoing income generation, as these programs required reserving land to avoid agricultural activities (Zhu et al. 2016). However, other studies have found that when people associated program benefits, their willingness to participate was favorable (Wilcox et al. 2012).

Other sociodemographic characteristics were positive and statistically significant. In the case of the sex variable, a positive relationship was found between it and the willingness to participate. Since women were coded as one and men as zero, model three shows that women are more willing to participate than men; that is, if a woman is a woman, according to the Odds Ratio (OR), she is 2.18 times more likely to participate in the program. This is consistent with other studies that have analyzed the impact of sex, resulting in women having a tendency to participate. Also, for rural environments, López et al. (2020) found a positive relationship between the willingness to participate and women. Particularly notable is Dardanoni and Guerreiro's (2021) analysis of young people's willingness to pay for environmental protection, where they observed a greater willingness on the part of girls compared to boys. However, Ángel Pérez et al. (2006) point out a positive relationship between gender, when it is male, although their result was not statistically significant.

One explanation for the impact of gender on pro-environmental behaviors establishes the impact of gender roles imposed by society and the private or public sphere of pro-environmental action. According to this, the internalization of ideas of care in women is more strongly related to pro-environmental behaviors in the private sphere, such as the home; while in the public sphere, such as collective actions, it would characterize men more. In practice, the results in the first sphere are clear, but in the second, there is no conclusive result (Weiwei and Liman Man; 2023).

Educational level, for its part, was statistically significant and positively related. For this variable, basic education (primary, secondary, and no schooling) was grouped as a single low-education group, coded zero; and secondary and higher education levels as another group, coded one. Model three indicates, according to the OR, that when a person has a high level of education, they are 1.899 times more likely to decide to participate in the program; that is, a high level of education has a positive impact on the willingness to participate. This result has also been observed in other analyses. Tavárez et al. (2023) found that the most involved individuals in environmental management initiatives were more educated than those who did not. Zhu et al. (2016) noted that 73 percent of professionals participated, while 32 percent of illiterate individuals were willing to do so.

This may be explained by the influence of education on scientific and critical thinking. Thus, Tavárez et al. (2023) mention that "educated residents are likely to have a deeper understanding of the multifaceted contributions that forests make to society." Zhu et al. (2016) note that a higher level of education among farmers is associated with greater environmental sensitivity and willingness to accept new ideas.

Finally, the variable for the level of perception of ecosystem services (LPE) proved to be positive and statistically significant. This variable was grouped into four ordinal levels: no or very low perception (zero), low perception (one), medium perception (two), and high perception (four); this means that, since these are ordinal levels, the higher the level, the higher the perception. Model three revealed that, as the level of perception increases, the probability of willingness to participate increases by 1.427 times. That is, people who perceive and attach greater importance to ecosystem services are more willing to participate in the program.

This result is expected, given the experience observed in other studies. Thus, Inostroza et al. (2020) finds a positive relationship between environmental knowledge and a positive attitude toward the environment; they also point out that people with environmental knowledge are more concerned and less likely to not participate (protest by saying no to participation). Similarly, Kim and Petrolia (2013) report greater willingness when they associate the benefits of hurricane protection with mangroves in Louisiana . Zhu et al. (2016) do not find a significant relationship between ecological awareness and values with the willingness to participate.

Conclusions

The results obtained show that the willingness to participate in environmental conservation programs in the Sonora River region is closely linked to people's perceptions of ecosystem services. As recognition of environmental benefits—both provisioning and regulation—increases, the likelihood of individuals engaging in collective environmental protection actions increases significantly. This finding reinforces the theoretical hypothesis that the subjective appreciation of the natural environment is a fundamental driver of collective action on environmental matters.

From a public policy perspective, this result suggests that any community-based conservation or ecological restoration strategy must explicitly integrate components of environmental education, social communication, and citizen participation. Strengthening the perception of ecosystem services not only increases environmental awareness but also generates legitimacy and social sustainability for government programs. In other words, effective environmental policy requires both technical instruments and an informed and empowered citizenry.

The analysis also demonstrates that sociodemographic characteristics play a significant role in the likelihood of participation. In particular, women are more willing to get involved, confirming a trend observed in other rural contexts in Latin America and potentially associated with socially assigned roles of caregiving and domestic responsibility. This result calls for strengthening female leadership in local environmental management and promoting the inclusion of women in community decision-making and environmental monitoring bodies.

In contrast, occupation showed a significant, negative effect on willingness to participate, which could be interpreted as a manifestation of the time and resource constraints faced by workers in the region, or a limited perception of the direct benefits derived from environmental participation. This finding suggests that programs should be designed with compensation mechanisms, incentives, or economic co-responsibility schemes that recognize the opportunity costs associated with participation.

Although variables such as age and income were not statistically significant, their inclusion remains relevant for understanding the heterogeneity of environmental behaviors. Future studies could explore their interactions with other psychological and contextual variables, such as institutional trust or sense of community, to refine our understanding of the determinants of environmental action.

Finally, in a context as complex as that of the Sonora River—marked by socio-environmental conflicts, institutional mistrust, and the legacy of ecological disasters—the generation of empirical evidence on the factors that promote or inhibit social participation constitutes a substantive contribution to the formulation of public policies that are more sensitive to local realities. Promoting community environmental monitoring mechanisms, supported by academic and government institutions, could become an effective tool for restoring trust, improving transparency, and strengthening citizens rights to a healthy environment.

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