

Local Perceptions of Hydrocarbon Exploitation Operations in the Northeastern Region of Mexico*

Percepciones locales sobre las actividades de explotación de hidrocarburos en la región noreste de México

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ABSTRACT

This work studies the perceptions of the inhabitants of the Burgos Basin about the exploitation of hydrocarbons in that region in Mexico's northeast. It uses a sample of 1 549 people and a logistic regression model for the analysis. The results show that 90.7 percent of the people who perceive an effect associate it with something negative. The findings also show that access to means of communication, and information about the issue, have an effect on the formation of perceptions. Because of insecurity in the localities, the survey was not carried out in a random and systematic way. Still, this study, utilizing a little-used approach in Mexico, shows the perceptions, and the driving factors behind them, that inhabitants have about the extractive operations that take place in the region.

Keywords: 1. hydrocarbons, 2. public perceptions, 3. information, 4. Mexico, 5. Burgos Basin

RESUMEN

En este trabajo se estudian las percepciones de los habitantes de la cuenca de Burgos acerca de la explotación de hidrocarburos en dicha región ubicada al noreste de México. Se emplea una muestra de 1 549 personas y un modelo de regresión logística para el análisis. Los resultados indican que 90.7 por ciento de las personas que perciben un efecto, lo asocian con algo negativo. Y que el acceso a los medios de comunicación, y a la información en torno al tema, tiene un efecto sobre la formación de las percepciones. Debido a la inseguridad en las localidades, el instrumento no fue aplicado de manera aleatoria y sistemática. A pesar de ello, el trabajo expone, desde una perspectiva poco estudiada en el país, las percepciones que los habitantes presentan sobre las actividades extractivas que se practican en la región y sus determinantes.

Palabras clave: 1. hidrocarburos, 2. percepciones públicas, 3. información, 4. México, 5. cuenca de Burgos.

Date of receipt: May 30, 2017.

Date of acceptance: August 24, 2017.

*Tex and quotations originally written in Spanish.

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<http://dx.doi.org/10.17428/rfn.v30i60.1139>

INTRODUCTION

The recent opening of the national energy market promoted by the energy reform of 2013 has increased Mexico's attractiveness to private companies for carrying out hydrocarbon exploration and exploitation operations. A report by the U.S. Energy Information Administration (EIA, 2013) says Mexico has a large potential for the exploitation of natural gas, and particularly of oil shale gas, above all in its northeast region where the Burgos Basin is located. Consequently, the arrival of private investment, both national and foreign, to explore and exploit the hydrocarbons in this region, is just a matter of time. However, the extraction of this type of unconventional gas requires the controversial technique of hydraulic fracturing, or fracking. This is often the subject of debate because of the impact fracking can have on the environment. And acceptance on the part of the population that lives in localities close to where these operations take place continues to be in question. Despite these issues, such operations have been widely undertaken in the United States in the formation known as Eagle Ford. This shale gas zone neighbors our area of study in Mexico.

The northern region of Mexico produces about 94.6 percent of the country's non-associated natural gas; the Burgos Basin contributes 73.7 percent of the production of the northern region, followed by Veracruz with 25.2 percent in 2015 (Pemex, 2016). The region's hydrocarbon exploration and exploitation operations have been carried out by Pemex as well as by private companies subcontracted by the para-state company. As a result, inhabitants of the region have developed perceptions about the operations of these companies.

The objective of this work is to study the perceptions of the inhabitants of the six municipalities in the Burgos Basin about hydrocarbon exploration-exploitation operations. As part of the study, a survey was carried out in 1 549 homes that asked about how they perceive the development of this type of industry in their locality, that is, whether they see it as beneficial, damaging, or whether they have any perceptions about it at all. Using the data collected, a logistic regression was estimated to analyze the impact of a number of variables on people's perceptions: means of communication, access to information about hydrocarbon issues, and knowledge about human rights.

This work is divided into four sections. In the first, a review will be made of research that has studied the issue of energy boomtowns, as well as perceptions of issues involving hydrocarbon exploitation, with an emphasis on research involving natural gas and oil shale gas, given that our area of study has tremendous potential when it comes to the development of this type of energy resource. In the second

section, the area of study, the sample, the type of sampling carried out, and the instrument applied are described. In the third section, the results of the study are presented; in the last section, conclusions and recommendations resulting from the research are provided.

BACKGROUND

The exploitation of hydrocarbons such as oil, natural gas, and coal represent an important activity for the economy, as their extraction/production makes it possible to obtain fossil fuels. According to the International Energy Agency (2014), more than 70 percent of the world supply of primary energy comes from this type of fuel. This shows the importance of these energy resources in the economic structure of a country. This is the case whether it involves the sale of or income from the extracted resource, the creation of direct employment, or the economic revenue that is generated around these types of operations.

At the macroeconomic level, the economic benefits of natural resource exploitation for obtaining gas and oil are undeniable; their exploitation is necessary to promote the economic growth of the country. The problem generated by these types of operations is that their social and environmental impacts are very high at the local level. Also, when it comes to political discourse, there is a tendency to exaggerate the economic benefits of these operations, as well as to minimize the social costs in the pursuit of carrying out productive projects. Both the economic benefits and the social costs tend to be associated with the quantity of natural resources available in a place and commonly form part of an up-and-down, boom-bust cycle. During the boom phase, the economic benefits become readily apparent, but in the bust phase they tend to recede and on occasion even disappear. This is pointed out by Jacobsen and Parker (2014), who study the evolution of income and unemployment rates during the boom-bust cycle in localities where extraction-exploitation operations for oil and gas take place in the eastern part of the United States. Their results show that in the short term, the economic benefits are positive, but that in the long term unemployment rates rise above and income falls below their levels before the boom. Thus, for example, in the short term during the energy boom, income measured by per capita GDP increased up to 10 percent. But during the bust, in the long term, income is about 6 percent less than it would have been had the boom not taken place. The authors concluded by saying that the energy boom experienced by the communities is a curse.

Other authors who have addressed the issue of the boom-bust cycle from a more sociological perspective have focused on social impacts. Such is the case in Kohrs (1974), who says that in cities where hydrocarbon exploitation operations have developed, the growth rates of mental problems, crime, divorce, suicide, and alcoholism have increased in comparison with cities without such economic activity.

Davidson (1979) says that such impacts depend in large part on how long the residents have lived in the area. That is, the impact is different for people who have lived in the place before the development of the industry's operations than for the people who came because of the establishment of those operations. For example, recently arrived workers and their families commonly experience poor conditions when it comes to the quality of their housing, public services, and medical services, not to mention the stress involved in moving to a strange and isolated place that might reject them, possibly causing social isolation. In addition, longer-term residents of the locality may undergo changes, such as greater stress because of an increase in vehicular traffic and noise. They also may alter their customs and habits; this could include beginning to always close the front door of their home or avoiding walking alone in places and at times they used to do so (Jacquet, 2009). Similarly, Brown, Dorius, and Krannich (2005) say that during the first stages of development of the exploitation operations, communities experience a strong negative perception in comparison with previous periods. This is possibly due to uncertainty and a lack of information.

The analysis of public perceptions in terms of the hydrocarbons issue, particularly that of unconventional exploitation through hydraulic fracturing, or fracking, has gained momentum in recent years. For example, Choma, Hanoch, and Currie (2016) study the attitudes of and impact of information on the two main political orientations in the United States of America regarding the exploitation of shale gas by fracking. The orientations were defined as conservative and liberal (Republicans and Democrats, respectively). Carrying out a survey of 412 U.S. adults, as well as a correlation and regression analysis, these authors found that people who said they were conservative saw the exploitation of oil shale gas through the technique of hydraulic fracturing as a business opportunity, overestimating the economic benefits. Meanwhile, those who said they were liberal tended to think more about the issue, emphasizing the environmental damage; this group of people was inclined to overvalue the environment. The authors say basic knowledge about the issue is key, and therefore that it is necessary to educate individuals about the economic, social, and economic implications when it comes to fracking.

Similarly, Boudet, Clarke, Bugden, Maibach, Roser-Renouf, and Leiserowitz (2014) carried out an online national survey called *Climate Change in the American Mind*, with questions about the acceptance of the unconventional exploitation of hydrocarbons through fracking. They developed a regression analysis with a binary dependent variable to identify the variables that predict acceptance of these types of operations. The results of their study say that Americans are not very familiar with the issue. The regression analysis found that age, conservative political ideology, educational level, beliefs about economic benefits, and the frequency of TV watching had a positive impact on perceptions of acceptance. Variables such as being female, having a vision of social equality, knowledge of the impacts on the environment, frequent reading of a newspaper, and familiarity with the issue of fracking had a negative impact on acceptance of the development of hydrocarbon exploitation operations through hydraulic fracturing.

Schafft, Borlu, and Glenna (2013) identify the perceptions of risk and opportunity that are generated by the exploitation of oil shale gas. To do this, they carried out a survey of school administrators in 309 local schools in the Marcellus Shale region in the U.S. state of Pennsylvania. The survey asks about issues such as perceived social, economic, and environmental changes in the community. The authors estimate various regression models through ordinary least squares and conclude that the best model is one that includes variables of urbanity, socioeconomic status, attitudes, and the number of wells close to the region. However, the authors acknowledged that only attitudes and the number of wells were decisive in explaining the perceptions. The study's results show that there is a very strong positive association between the perceptions of risk and opportunity associated with the issue of extraction of the gas, and that the intensity of these perceptions is associated with the quantity of wells drilled in the region. Also, these authors found polarized results on the issue, given that, on the one hand, people know that the development of this industry represents a revitalization of economic activities, but at the same time, a significant environmental risk.

Theodori (2012) examines the perception that the population in general has about the development of the natural gas industry in two Texas counties that form part of the Barnett Shale region. Employing a bivariate and multivariate logistic regression, he found that the residents of a county where the industry is more established have more negative perceptions than residents of another county where the industry is less established. Another study by Theodori and Jackson-Smith (2010) carried out a survey of 450 homes selected in the Tarrant County, Texas, to

explore the population's perceptions about the natural gas industry's operations. Employing a multivariate logistic regression model, the authors found that the population in general does not trust the intrusion of the gas industry and dislikes the social and environmental problems generated by the development of this industry, while also acknowledging the economic benefits associated with the operations. Also, the authors say that individuals with more positive views about the economic factors and those with more negative social/environmental views are more likely than their respective counterparts to attend meetings to learn more about the issue. Similarly, individuals with more negative social/environmental views are more likely to complain about the exploitation operations, whether to a government agency or a local official, and to express their discontent by voting against political candidates who favor fracking.

In a case involving the United Kingdom, Whitmarsh, Nash, Upham, Lloyd, Verdon, and Kendal (2015) carried out an online survey to research the factors that predict the acceptance and the impact of different informative messages on public perceptions. They developed a sample composed of 1 457 participants and divided into three regions of the United Kingdom where shale gas exploitation operations have begun. The results of their work show that the U.K. population has little knowledge about the technologies for generating energy. Fracking had the least acceptance or favorability, although the largest proportion of those surveyed were classified as indifferent. Also, the authors did not find significant differences in acceptance based on geographic location. The variables that led to more positive acceptance were gender, education, skepticism about climate change, conservative political ideology, and attachment to place. Having an environmental identity and being from a rural region caused more negative views. Contrary to what was expected, people with greater attachment to place had a greater positive acceptance, which requires a qualitative study of greater depth in this case. In terms of messaging, it was found that individuals who read the environmental or economic information had attitude changes that were more accepting of the energy operations. And contrary to what was expected, having an environmental identity did not interact with the message. In other words, a message framed in environmental terms did not have a greater effect on those with a pro-ecological point of view than on those who do not.

In England, Williams, Macnaghten, Davies, and Curtis (2017) carried out a qualitative study of the perceptions. They employed a focus group methodology, using six different groups, composed of eight persons each, in the north of the country. The study's objective was to study the relationship between the information provided by

institutions charged with making policy on fracking and their understanding by the participants in the selected sample. The results indicate that information provided by political institutions was based mainly on issues of technical viability and safety, limiting the assimilation of the issue by the audience. This incomplete message, according to the findings of the authors, did not fall within the citizens' framework of thinking. This indicates that in order for there to be a greater policy acceptance, a reorientation is needed of the institutional rhetoric where broader issues are addressed in the message, such as trust, inclusivity, and epistemological pessimism, among others. Also, the authors say that the institutional rhetoric managed by the politicians on fracking has only served to try to legitimize the policy and to persuade and tranquilize the publics opposed to the policy of hydraulic fracturing exploitation. Thus, a reorientation of the message could resolve possible controversies.

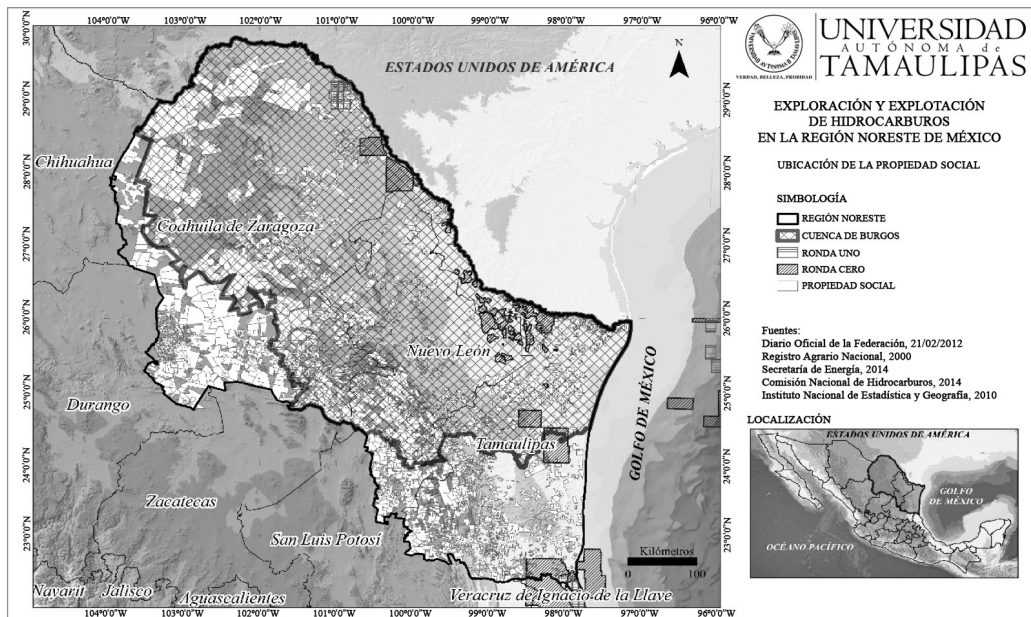
In Mexico, Morales and Roux (2015) carried out a baseline study in San Fernando, Tamaulipas, to identify the socioeconomic characteristics of the municipality and the perceptions of the people who live there. This was done because this municipality is in an area of opportunity for unconventional gas exploitation (shale gas). The authors performed a survey in 331 homes in the municipal seat and found that people perceive that conventional hydrocarbon exploitation, which has been in development there, has been of little benefit to the municipality.

As seen in the above paragraphs, there is broad body of literature, mainly at the international level, that analyzes public perceptions in relation to the exploitation of hydrocarbons, information about the issue, educational levels, income levels, frequency of use of means of communication, the message, geographic location, and political orientation, among others. This has occurred even though unconventional hydrocarbons are a relatively recent issue. The findings encountered in this review show that the issue has been studied using qualitative and quantitative methodologies, multiple and logistic regression techniques, and correlation analysis, among others. In our case, a semi-structured survey was used to record the perceptions inhabitants have about exploitation operations that have been taking place in the area of study, and a logistic regression model was developed to analyze the effect of access to means of communication and information, mainly about the perceptions expressed by those surveyed. It is worth mentioning that in Mexico, the literature about the impact of the hydrocarbon exploitation operations, and about public perceptions, has just begun to develop.

METHODOLOGY

Sample and type of sampling: The information gathering took place in six municipalities located in the Burgos Basin in Mexico's northeast. In the state of Tamaulipas, the municipalities were San Fernando and Burgos; in Nuevo León, the municipalities of China and Anáhuac; and in Coahuila, the municipalities of Guerrero and Hidalgo. It was decided to work in these areas because of their proximity to gas wells (particularly of oil shale gas) reported by the National Hydrocarbons Commission, or Comisión Nacional de Hidrocarburos (CNH, 2016). Even though there are other localities closer to the gas fields reported by the CNH, according to data from the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía, or Inegi, 2015) and the microregions of Sedesol (2013), these localities do not report inhabitants or have very few homes, which are not commonly used for living purposes during the year. Map 1 delineates the Burgos Basin and the states it occupies.

MAP 1. Delineation of the Burgos Basin



Source: Centro de Investigaciones Sociales-Universidad Autónoma de Tamaulipas (2015).

More than 1 549 semi-structured surveys directed at people above the age of 18 found at home at the time of the visit, from August to November 2015, were carried out. The implementation of the survey was coordinated by the Social Research Center (Centro de Investigaciones Sociales) of the Universidad Autónoma de Tamaulipas as part of the project “Diagnosis and Analysis of the Social Impact of the Exploration and Exploitation of Shale Oil/Gas” (Diagnóstico y análisis de impacto social de la exploración y explotación del *oil/gas shale*), related to culture, legality, public services, and the participation of social actors in the states of Coahuila, Nuevo León, and Tamaulipas. The size of the sample was estimated taking into account the total number of the homes in the respective municipal seats with a 95 percent confidence level, a margin of error of 5 percent, and a variance of 0.25. The implementation of the instrument was done in areas delimited as the center, north, south, east, and west of the municipal seat. Nevertheless, for reasons of insecurity¹ it was not possible to systematize all the homes in the neighborhoods so that they would have same probability of being selected, for which reason casual or incidental and quota sampling was used,² which gives us a good description of the characteristics of the municipality but limits to a certain extent the generalizability of the results. In Table 1 the distribution of the surveys carried out is specified, as well as the approximate distance from the municipal seat to the closest well zone. Given that the extraction of shale gas in Mexico is not as developed as in the United States, the location of the wells was difficult to establish; to do so, the reports of the National Hydrocarbon Commission were consulted to identify the places through field visits and by using Google Earth. For this reason, the distances used are approximate and it was not possible to define an a priori distance from the well to the city.

¹ Currently, the country is immersed in a crisis of insecurity reflected in an increase in criminal acts such as killings, kidnappings, rapes, robberies, etc., and the area of study is no exception. Thus, before gathering the information it was necessary to advise the municipal authorities that surveys were going to be carried out in the homes; these same authorities recommended which neighborhoods should be entered and which should not.

² In casual or incidental sampling, individuals who are going to be interviewed are selected directly and intentionally, and in quota sampling the interviewer is given the profiles of the persons to be interviewed, leaving to his or her discretion the choice of whom to interview, provided that they meet the desired profile. In our case the objective is homes in the municipal seat that have an adult present at the time they are visited.

TABLE 1. Size of the Sample and Approximate Distance from the Well Zone

<i>State</i>	<i>Municipality</i>	<i>Municipal seat</i>	<i>Approximate distance to the wells</i>	<i>Inhabited homes</i>	<i>Sample at 95 % C.L. and 5 % margin of error</i>	<i>Surveys carried out</i>
Nuevo León	Anáhuac	Anáhuac	18 km	4 256	352	305
	China	China	9 km	2 555	334	331
Coahuila	Hidalgo	Hidalgo	10 km	411	199	217
	Guerrero	Guerrero	22 km	272	159	208
Tamaulipas	San Fernando	San Fernando	16 km	8 001	367	314
	Burgos	Burgos	6 km	384	192	174
Total				15 879	1 603	1 549

Source: Prepared by the authors with data from the Population and Housing Census 2010 of Inegi (2015) and CNH (2015).

The instrument: The questionnaire was composed of five sections and included 51 questions of open and closed types. The first section inquires about socioeconomic issues; the second, about the characteristics of homes and public services; the third, about public safety; the fourth, sociocultural practices; and the fifth addresses what knowledge the people have about their human rights, as well as the perceptions they have about the gas exploitation operations that have been taking place in the region.

RESULTS

This section presents the basic statistics and results of the logistic regression employed. In Table 2 the distribution percentages of the study variables are seen.

TABLE 2. Basic Statistics

<i>Gender</i>	
Male	82.9 %
Female	17 %
<i>Age</i>	
Average	50 years
<i>Income per month</i>	
Less than 1 000	7.2 %
1 000 to 2 000	19.8 %
2 001 to 4 000	32.6 %
4 001 to 6 000	20.7 %
6 001 to 8 000	6.7 %
More than 8 000	6.7 %
Not received/not answered	5.9 %
<i>Education</i>	
Null	10.3 %
Basic	68.4 %
High school	12.9 %
University	8.1 %
<i>Home</i>	
Own house	73.4 %
Number of rooms	4
<i>Communication methods</i>	
Landline phone	34.3 %
Cable TV	46.1 %
Internet	17.6 %
Cellphone	73.6 %
Satellite TV	29 %
<i>Knowledge or information</i>	
Do you know what your basic human rights are?	82.4 %
Have you received information from the authorities or businesses about exploration-exploitation operations?	6.6 %

Source: Prepared by the authors using survey data.

Table 2 shows that access to means of communication is low except in the case of those who have cellphones. This is highly important, as when people have little access to the communications media it makes it more difficult to have information.³ Also, if we consider that 93.4 percent of the people said that no authority, agency, or company provided them with any kind of information about the exploration and exploitation operations that have been carried out, surely the inhabitants of the region are uninformed. In this sense, one of the objectives of this work consists in determining whether the means of communication mentioned are effective in transmitting an idea or influencing residents' perceptions. This is why these variables are included in the regression analysis.

Perceptions about the extraction of gas in the region

The survey results show that 37.3 percent of those interviewed perceive an effect attributed to the development of the industry. However, 62.7 percent do not perceive any type of effect; in other words, the majority of those interviewed in the region of study do not perceive benefits or harm from the development of the gas exploration and exploitation operations.

TABLE 3. Percentage of People Who Perceive an Effect at the Local Level

<i>Perception</i>	<i>Municipality</i>						<i>Total</i>
	<i>Anáhuac</i>	<i>Burgos</i>	<i>China</i>	<i>Guerrero</i>	<i>Hidalgo</i>	<i>San Fernando</i>	
No effect is perceived	72.5	63.2	65.3	54.8	74.2	47.5	62.7
Effect is perceived	27.5	36.8	34.7	45.2	25.8	52.5	37.3
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

Source: Prepared by the authors with data from the survey.

Of a total of 1 549 people who responded, only 578 perceived an effect. And of the persons who perceived an effect, only 9.3 percent associated it as beneficial, and this was commonly related to the creation of jobs. This means that 90.7 percent of those who perceive an effect see it as negative. Table 4 breaks down the

³ In addition to access, what is important is the frequency of use and the content of the message that is read or heard.

percent distribution of the people who perceive an effect attributed to gas exploitation operations at the local level.

TABLE 4. Percentage of People Who Perceive a Positive or Negative Effect at the Local Level.

<i>Perception</i>	<i>Municipality</i>						<i>Total</i>
	<i>Anáhuac</i>	<i>Burgos</i>	<i>China</i>	<i>Guerrero</i>	<i>Hidalgo</i>	<i>San Fernando</i>	
Negative	98.9	89.1	84.3	95.7	89.3	88.5	90.7
Positive	1.1	10.9	15.7	4.3	10.7	11.5	9.3
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>

Source: Prepared by the authors using survey data.

Some of the effects that the people expressed while the survey was being carried out were the following: On the negative side, standing out were the constant tremors, water, air, and land pollution, water scarcity, damage to roads, blocking of paths due to vibration that prevented the collection of water for livestock, gas leaks, explosions, health issues because of gas emissions, damages to homes, injustice, and crime, among others. On the positive side, the majority recognize the creation of more work, as well as improvement in schools and paving.

Estimate of impacts

The effects were estimated for variables such as gender, schooling, income, owning a home, number of rooms, access to a fixed telephone line, internet, cable TV, satellite TV, knowledge of basic rights, and information provided about the issue by local authorities and the municipality where the interviewee was located. In terms of the probability of perceiving an effect, $y = 1$ if an effect is perceived and $y = 0$ if no effect is perceived. Thus, a logistic regression was estimated through the maximum likelihood method with the statistical software SPSS version 19. Table 5 presents the results of the analysis.

TABLE 5. Estimates

<i>Variable</i>	<i>Coefficient (B)</i>	<i>Odds Ratio Exp(B)</i>	<i>Significance</i>
Gender	0.215	1.239	0.169
Age	0.004	1.003	0.343
Income per month			
1 000 to 2 000	0.321	1.379	0.199
2 001 to 4 000	0.302	1.352	0.219
4 001 to 6 000	0.267	1.307	0.307
6 001 to 8 000	0.189	1.208	0.55
more than 8 000	0.752	2.121	0.020**
Nothing	0.367	1.443	0.252
Education			
Basic	0.546	1.726	0.011**
High School	0.519	1.68	0.049**
University	0.631	1.878	0.031**
Housing			
House	-0.403	0.669	0.002**
Rooms	0.112	1.118	0.008**
Means of communication			
Landline telephone	-0.184	0.832	0.223
Cable TV	-0.125	0.882	0.389
Internet	0.473	1.604	0.009**
Cellphone	0.263	1.300	0.059***
Satellite TV	-0.239	0.787	0.110
Rights	0.456	1.577	0.003**
Information	0.530	1.699	0.016**
Municipality			
Anáhuac	-0.838	0.432	0.000**
Burgos	-0.515	0.597	0.012**
China	-0.853	0.426	0.000**
Guerrero	-0.239	0.787	0.228
Hidalgo	-1.146	0.318	0.000**
Constant	-1.761	0.172	0.000**
Nagelkerke R squared*	0.120	Sensitivity	31.4 %
Hosmer-Lemeshow (Cg)	0.226	Specificity	87 %

* The Nagelkerke R squared indicates that the variables considered in the model only explain 12 % of the variability. The analysis of the adjustment of the model is statistically significant in accordance with the Hosmer-Lemeshow statistical test (Cg) saying (p-value = 0.226) The estimated model allows 66.2 % of cases in general to be classified correctly; the sensitivity of the model, that is, the probability of suitably classifying the cases with effect is 31.4 %, while the specificity, that is, the probability of suitably classifying the cases without effect, is 87 %.

** Significant at 5 %.

*** Significant at 10 %.

Source: Prepared by the authors.

DISCUSSION

The findings indicate that the vast majority of those surveyed do not perceive the development effects of these types of operations. Nevertheless, the vast proportion of people who do perceive an effect see it as negative. This matched the results found in Tarrant County, Texas, by Theodori and Jackson-Smith (2010), where the population was upset with the social and environmental problems generated by the development of the gas industry, while also recognizing its economic benefits.

Age and gender were not statistically significant for explaining the perceptions in our sample. However, income and educational levels did play a role in determining whether inhabitants perceive an effect. For example, the odds ratios say that residents with higher education perceived effects 1.878 times more than those less-educated, and as most of the effects were seen as negative, we can say that a greater level of education is associated with a negative perception, a result contradictory to that found by Boudet et al. (2014), who found that high levels of education tend to favor the acceptance of unconventional exploitation of hydrocarbons through fracking. However, the authors postulated a priori the opposite.

The categorical variable used to measure monthly income was statistically significant, although only for those inhabitants who had a monthly income above 8 000 pesos. People who say they received more than 8 000 pesos a month perceive the effects 2.12 times more than those who say they earn less than 1 000 pesos. In terms of housing characteristics, it was found that the more rooms a home had, the more likely it was that people living there would perceive an effect. However, the final effect depends on whether they own the home they live in, as inhabitants who say they have their own home perceive effects 0.699 times less than those who don't own one.

In the case of the variables involving access to means of communication, it was found that it was only when people had internet access in the home or on cell-phones were the variables statistically different than 0 and greater than 1. This indicates that a person who has internet in the home perceives the effects 1.604 times more than a person who does not have this means of communication. Likewise, a person who has a cellphone perceives the effects 1.3 times more. The effectiveness of this internet access can be attributed to the availability of information in terms of quantity, quality, and speed. If, say, a user requires some type of information, he or she can go to the internet and download any number of informative articles that allow him or her to form an opinion about the issue. When it came to having access to cable or satellite TV, no statistical evidence was found showing an

impact on perceptions. However, authors such as Boudet et al. (2014) say the frequency of use of television does have a positive effect on the acceptance of these types of operations. Nevertheless, it must be made clear that this work uses the variable of *access*, while Boudet et al. consider the *frequency of use*. In this respect, it is important to mention that the informational message that is received, much more so than access and frequency of use, is instrumental when it comes to causing an impact (Whitmarsh et al., 2015; Williams et al., 2017). This is why it necessary to have in-depth analysis of this point.

The variable that registers access to information provided by authorities or those responsible for the project is significant and greater than 1. This means that a person who has information perceives the effects 1.699 times more than those inhabitants who do not possess information. This means that it can be said that an increase in information provided by authorities about the operations developed by the companies in the region would help increase the effects perceived by the region's residents. However, in our case, the people who perceive effects from the development of hydrocarbon exploitation operations generally see them as negative. These results fall under the model of unidirectional scientific communication, where it is assumed that public unease is essentially caused by a lack of knowledge. However, this knowledge can be acquired through the provision of precise information, and communicating this information and educating people about the scientific knowledge on the risks and benefits could result in public support and the acceptance of technologies (Williams et al., 2017).

Similarly, the variable that captures knowledge about basic human rights—a healthy environment, potable water, and dignified housing—was statistically relevant. Consequently, a person who knows his or her basic human rights perceives 1.577 times more the effects attributed to the development of the industry compared with people who do not know their rights. This shows that a society that is informed can often perceive to a greater extent the effects that come from hydrocarbon exploitation operations. It should be taken into account that a society that knows its rights can demand, at any time, their compliance in the face of suspicions that industry is violating them. This shows why companies should always respect the legal and environmental framework, hold informational forums about their plans and programs of action, and explain in a detailed manner the functioning of their main operations so that the people have knowledge about the processes that take place and about the form in which resources are exploited in their region.

Finally, it was found that the perceptions about companies' operations to exploit hydrocarbons varies from place to place. Thus, for example, the inhabitants of Burgos perceive the effects 0.597 times less than the inhabitants of San Fernando, and those of Anáhuac perceive 0.432 times less than those of San Fernando. These differences can be explained by the level of development of these types of operations, such as the quantity of exploited wells and the distance from the wells to the city (Theodori, 2012). In this case, if we observe the distance from the wells to the city, in Table 1, and the percentages of people with a negative perception, in Table 4, a positive relationship between both variables can be seen. This indicates that the people who live closer to the wells in the region perceive negative effects to a lesser extent. This mirrors the work of Jacquet (2012), who found that people surveyed in the north of Pennsylvania who had links to the gas industry tended to express their support for these types of operations. Nevertheless, Boudet et al. (2014) do not find differences. This is why it is necessary to identify in greater detail the level of development that these types of operations have in each place, examining variables such as the number of wells in each place and researching this issue in a qualitative way.

CONCLUSIONS

This work studied the perceptions of the inhabitants in six municipalities in the Burgos Basin about hydrocarbon exploitation operations; this basin is in the northeast of the country in the states of Tamaulipas, Nuevo León, and Coahuila.

The results show that while many people in the region perceive effects from the development of this kind of industry, the majority of the inhabitants do not. The vast majority of those who do perceive an effect associate it as being negative.

Using an analysis of the variables that influence the perceptions of those surveyed in the six municipalities, it was found that level of income, education, housing characteristics, internet access, having a cellphone, people's having information about the issues and about their basic human rights, and geographic location are instrumental in explaining the perceived effects. This is important for the configuration of strategies and public policy that are needed so the inhabitants of the region can better perceive the effects of the development of these types of operations. This is because the arrival of national and foreign companies dedicated to the exploitation of hydrocarbons and particularly of oil shale gas to the region of study is imminent.

Also, the role of the authorities in the three levels of government is fundamental for providing information to the community, and for monitoring compliance with and sanctioning violations of existing regulations. The companies responsible for the projects of exploration and exploitation that arrive in the region should approach society using clear schemes of social responsibility and above all should generate a close relationship that contributes to keeping the inhabitants of the region informed. Finally, it is recommended that further studies be carried out to evaluate the acceptance of the exploitation of unconventional hydrocarbons, specifically through the technique of hydraulic fracturing.

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