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THE PROVISION TO PAY TO REMEDY AN ENVIRONMENTAL DAMAGE IN THE CONTEXT OF GLOBAL CLIMATE CHANGE. CASE STUDY OF THE METROPOLITAN AREA OF LA COMARCA LAGUNERA, MEXICO.

Abstract:

The global climate change (IPCC, 2014) causes unexpected and severe hydrometeorological phenomena, among which are the so-called "waterspouts." These phenomena, because of the rarity of their appearance, strongly impact urban infrastructure which, as is the case of the metropolitan region under study, (located in a semi-desert climatic zone, and therefore lacking in storm drainage) is not prepared for the adequate management of the water flow generated by the extraordinary hydrometeorological phenomenon. The aforementioned causes the vulnerability of the population to house floods, flooding of vehicular traffic routes, automobile accidents, the appearance of disease-transmitting vector pests, and, in general, the disruption of community life over several weeks.

Despite sharing resources, productive and academic activities and being a region with its own social identity, until now, this metropolitan area has lacked a common policy on the environment and adaptation to climate change.

Taking into account the above, a field investigation was carried out under the contingent valuation method (Cummings, Brookshire and Shultze 1986, Mitchell and Carson, 1989, Riera, 1994) in order to get closer to knowing the willingness to pay a "green tax". "(Riera, 1994, OECD, 2011, ECLAC, 2015) aimed at remedying the impact of the waterspouts and establishing the adequate infrastructure to adapt effectively to climate change.

The research consisted of conducting a survey among the population of the metropolitan area where 400 economically active people were asked, their willingness to pay, as well as the amount that would be willing to cover.

The results showed that 42% of the surveyed population, regardless of their personal income, level of education or area of the city in which they live, would be willing to pay to remedy the damage caused by extreme hydrometeorological events. This percentage is considered relevant as a basis for the design and execution of a public policy aimed at adapting to climate change in a context of scarcity of resources for municipal public finances and as a principle for the development of metropolitan policies that design and execute, joint and articulated way, policies and measures of adaptation to the impacts of climate change.

Keywords:

Contingent valuation, climate change, vulnerability, comarca lagunera.

JEL Classification: Q58

Introduction

It is important to mention that this document is an academic experiment carried out with material resources contributed by the Autonomous University of Coahuila, Mexico, and carried out in the field by students from the Sustainable Development groups, sections A and B, and by the group of Administration II of the Faculty of Fiscal and Financial Administration, during the school semester August-December 2017.

The research presented here follows a logic of exposure from the general to the particular. It begins by making known the context of climate change as a global phenomenon that affects the way of life of society in different aspects, both productive and safety for people's lives. Then we proceed to show in general terms the consequences that this phenomenon is causing in Mexico.

In order to give the exact dimension to the consequences of climate change, we analyze in a second moment the process of urban growth that Mexico has had in recent years, observing the distortions and imbalances that have been created as a result of the lack of planning, as well as by governance schemes that are behind the speed with which the economy moves and social interrelations in general.

In a third moment, the characteristics of the emergence and expansion in Mexico of metropolitan areas (1 million inhabitants or more) are described, highlighting the lack of institutional mechanisms to coordinate efforts between authorities from different political spheres.

In this regard, the Metropolitan Zone of La Laguna (MZLL) is analyzed, which is the case of the study of this investigation, whose political-administrative characteristics have been exceeded due to the urgency of the attention to atypical hydrometeorological phenomena. A description of the geographic-environmental and socioeconomic conditions is made in order to situate the importance of this metropolitan area in the context of the development of Mexico.

The level of analysis is made even more precise by showing the impacts caused by atypical hydrometeorological phenomena in 2017, which caused severe problems for the MZLL population and showed the lack of preparation in urban infrastructure to face these phenomena associated with climate change.

The fourth moment presents the results of the research carried out among inhabitants of the MZLL, in order to determine their willingness to pay an amount exceeding the property tax, as a financing mechanism for infrastructure works aimed at solving the flooding problems that occur with atypical rains.

The conclusions show, in addition to the analysis of the results obtained, a series of suggestions to start shortly concrete actions to adapt to climate change.

The document is accompanied by graphs that show the most significant results obtained by the investigation.

Global climate change and its impacts in Mexico

Group II of the Intergovernmental Panel on Climate Change (IPCC) in its fourth report: Impacts, Vulnerability and Adaptation (IPCC, 2014: 6), mentions that:

"The impacts of recent extreme weather-related phenomena, such as heat waves, droughts, floods, cyclones and forest fires, highlight an important vulnerability and exposure of some ecosystems and many human systems to the current climate variability (level of confidence). very high). The impacts of these extreme weather-related phenomena include alteration of ecosystems, disorganization of food production and water supply, damage to infrastructure and settlements, morbidity and mortality, and consequences for mental health and well-being. human. For countries, regardless of their level of development, these impacts are in line with a major lack of preparedness for the current climate variability in some sectors." (Emphasis added).

For its part, the National Institute of Ecology and Climate Change (INECC, 2018: 4) of Mexico, states that:

"The increase in temperature, accompanied by the increase in extreme hot days and the decrease in extreme cold and freezing days, have led to an increase in cyclones of category 3 or more and more severe droughts that together have affected 90% of the territory. In Mexico, between 2001 and 2013, those affected by meteorological phenomena are estimated at around 2.5 million people, while the economic costs totaled 338.35 billion pesos. In addition, the negative consequences are increased by social conditions such as poverty in various sectors of the population and the environmental degradation that affects their communities, which increases their vulnerability. "

Let's take a look at how the process of urban development has been in Mexico, as well as its environmental impacts.

The process of Mexico's recent urban development

Mexico took almost 170 years to transform from a rural nation to a mostly urban one, but less than 20 to become urban to preferably metropolitan. (Sobrino, 2007: 245).

When cities are constituted as centers of high competitiveness of production factors, they become the engines of the development of a country. The city is infrastructure, equipment, social and human capital and efficient government management (Cabrero, 2009).

This link city - development has been explained as a stable relationship between the product, the investment and the urbanization index, which means that economies of scale and agglomeration are relevant in Mexico. (Galindo, Escalante and Assuad, 2004).

The aforementioned, caused a growing phenomenon that was expressed in the systematic increase in the volume and proportion of population residing in urban areas, as well as in the multiplication of the number and size of their cities. In 1900, the country had only 33 cities of more than 15 thousand inhabitants where 1.4 million people lived, 10.4 percent of the country's total. In 2005 there were 358 cities, which housed 65.6 million people, 69.2 percent of the national population. (INEGI, CONAPO, SEDESOL, 2012).

Environmental impacts of urban development followed in Mexico

The Sectorial Program for Urban, Rural and Territorial Development 2013 - 2018 (SEDATU, 2013), clearly points out some of the policies followed in Mexico regarding housing and urban mobility, which have caused the resurgence of environmental problems in the country's cities .

The diagnosis made by the aforementioned Sectorial Program establishes, among other aspects, the following:

Living place:

- In the past decade, the model of attention to housing needs has privileged the massive granting of financing for new housing without considering the territorial and urban impact, while the development industry opted for the production of affordable housing on cheap land and away from urban centers and corridors and high-quality public transport stations.

Urban movility:

- The structure and dynamics of the cities gradually distanced the residential, industrial and commercial areas, in parallel the neglect of the supply of quality public transport and the provision of pedestrian and bicycle infrastructure, causing a greater number of trips with greater distance, which encouraged the use of the automobile.
- Federal resources for policies that encourage the use of automobiles significantly outperform investments to develop pedestrian, bicycle and mass transit infrastructure.
- The public transport service is not coordinated with land use policies and has lacked strategies that place emphasis on quality, safety, sustainability and comfort, which has been another factor to encourage the use of the individual automobile. (SEDATU 2013: 18).

Urban growth and metropolitan areas

The National Urban System (SUN), explains that metropolitan areas make up a complex territorial structure that includes different components:

- demographic concentration,
- economic-functional specialization and
- physical expansion over areas that involve two or more political-administrative units, be they municipal, state or in some cases overflowing national borders.

This process implies new challenges for public management in general and for environmental management in particular, as it is stated: The management of metropolitan areas involves the concurrence of two or more municipal governments, and sometimes state governments, with their respective authorities, who They may have plans and projects that are not necessarily convergent, and may cause:

- Lack of agreements in the attention of the problems of the metropolis,
- differences in urban regulations,
- conflicting administrative provisions and
- absence of effective mechanisms for intersectoral and intergovernmental coordination

When combined, these aspects represent serious obstacles for the proper functioning and development of the metropolises, particularly with regard to the planning and regulation of their physical growth, the provision of public services and the care of their environment (SEDESOL, CONAPO , INEGI, 2004).

To the above, it must be added that the adverse economic environment provokes a kind of dispute between local governments due to the scarcity of financial resources that complicates the convergence of interests over common strategic problems, such as air quality management. (Tudela, 1988).

From different approaches we have tried to define a public policy that makes a successful environmental management:

- There are those who have considered studying it from the definition of Watersheds
- Others, from a regional perspective, and
- Some others from the local spaces.

It is important to be able to define in the short term what should be the basic criteria to face the problem of urban sustainability. Undoubtedly, this may establish the basis for the definition of a public policy that is capable of adding to the three levels of government, as well as the actors involved (Ugalde, 2007).

The regional approach to development is more conducive to the infrastructure, equipment, services and, in general, the rationality of the development process, oriented to meet the needs of the regions and to value their resources and vocations, contributing to the attention of matters multi-faceted and intersectoral publics such as poverty, insecurity, raising the quality of life, social inclusion, productivity, sustainability, among others. (SEDATU, 2013: 23).

Let us now describe the unique characteristics of the metropolitan area of La Laguna, which is our object of study.

La Laguna Metropolitan Area

As already established above, the urban phenomenon of metropolization has had an accelerated dynamic in recent years. The following table shows the metropolitan areas of Mexico.

In the table the metropolitan area under study is distinguished, whose particularity with respect to the rest, resides in that this metropolis is conformed by 2 different federative entities. Each of which contributes 4 municipalities to such a metropolis.

Table 1 Mexico: 14 metropolitan areas with more than one million inhabitants

NAME OF THE METROPOLITAN ZONE (ZM) POPULATION (2015)	Millions of habs.
1 Valley of México	21.340
2 Guadalajara	4.796
3 Monterrey	4.478
4 Puebla-Tlaxcala	2.955
5 Toluca	2.189
6 Tijuana	1.939
7 León	1.714
8 Ciudad Juárez	1,423
9 La Laguna	1.313

10 Querétaro	1.214
11 San Luis Potosí	1.126
12 Mérida	1.064
13 Mexicali	1.026
14 Aguascalientes	1,017

Source: CONAPO, 2015. *Zonas metropolitanas de México*.

The birth of metropolitan areas in urban areas brought with it various problems such as environmental pollution, water scarcity, insecurity, deficiency in public services, inadequate urban transport and adequate traffic congestion.

The Regional Development Program of the North 2014-2018 of the Secretariat of Agrarian, Territorial and Urban Development (SEDATU) mentions that within the metropolitan areas of the North Region of the country the most important are Monterrey, Tijuana, Ciudad Juarez and La Laguna.

A strong growth of these cities is expected by 2030, which entails challenges in urban communications infrastructure, public transport, territorial planning, housing and water, among others.

The link of the three mentioned factors, together with the demand for infrastructure for the year 2030 as mentioned by SEDATU, has a high cost for public administrations that must provide the goods, security and services demanded by society at a high cost.

This leads us to take on the challenge of coordinating metropolitan issues, a topic of the greatest interest in the national urban debate and which is exacerbated in the MZLL by its interstate location.

It requires a concertation between the four municipalities of the two states (Torreón, Matamoros, Gómez Palacio and Lerdo) through an agenda of metropolitan issues, in the areas of: Good Government, Economic Development, Social Development, Urban Environment, Mobility, Environment and Sustainability that allow us to approach a common vision as the La Laguna Metropolitan Area.

Although the municipality of Torreón has worked to make municipal planning from a metropolitan perspective, it is necessary to specify between the governments of the states and municipalities of Coahuila and Durango, approval agreements of legal frameworks that facilitate the application of specific rules for programs and projects of common works for urban planning for the benefit of citizens.

Economic-social characteristics of the MZLL

As mentioned above, the MZLL is made up of four municipalities: Torreón and Matamoros belonging to the State of Coahuila de Zaragoza and Gómez Palacio and Lerdo belonging to the State of Durango.

Map 1: Geographical location of Region Lagunera

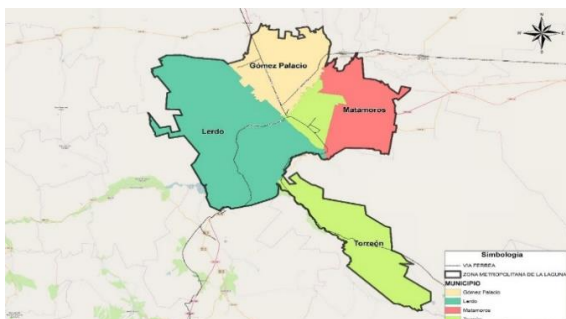


Source:

[Account with a total territorial surface of 502,799.38 hectares of which 473,142.14 are of rural surface and 29.657.24 of urbanized surface, what corresponds to that 94.10% of the territory is rural and 5.90% is urban.](https://www.google.com.mx/search?hl=es419&tbm=isch&source=hp&biw=1536&bih=710&ei=tsVYW-vSD4HmtQWjwKf4Ag&q=comarca+lagunera+mexico&oq=COMARCA+LAGUNERA&gs_l=img.1.4.017j0i30k1l3.1280.3739.0.17994.16.8.0.3.3.0.537.1483.4-1j2.3.0....0...1ac.1.64.img..10.6.1534....0.qqA0-xcwElc#imgrc=mkaMp2z8wwq4FM: Recuperado el 25 de julio de 2018.</p>
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The population registered according to INEGI in 2010 is 1, 215.817 inhabitants in the MZLL, (to 2015 according to CONAPO data is 1,313,161 inhabitants) distributed as follows: 998.090 inhabitants representing 82.19% live in the urban area and 217,727 inhabitants that represent 17.90% live in the rural area.

Map 2: Metropolitan zone of La Laguna



SOURCE:[### *General geographic-environmental characteristics of the MZLL*](https://www.google.com.mx/search?hl=es419&biw=1536&bih=710&tbn=isch&sa=1&ei=y8VYW8_eJIW6sQWtyrKIAg&q=mapa+de+la+zona+metropolitana+de+La+Laguna&oq=mapa+de+la+zona+metropolit+de+La+Laguna&gs_l=img.3...326974.343198.0.344134.42.30.0.12.12.0.315.4450.0j18j5j1.24.0....0...1c.1.64.img..7.23.2514...0j0i67k1j0i10k1j0i30k1.0.sx6g7UzkXLM#imgrc=SP1Oa77kMMSJtM: Recuperado el 25 de julio de 2018.</p></div><div data-bbox=)

The Comarca Lagunera is located in a region known as Bolsón de Mapimí, of arid and semi-arid geographical condition. Rainfall is scarce, reaching a maximum of 600mm to a minimum of 200mm per year. The Comarca Lagunera takes life from the existence of the Nazas and Aguanaval rivers, a singular example in Mexico of inland rivers that discharged their waters in the Laguna de Mayrán (Cervantes and Franco, 2007) before the hydraulic complex was built through the which is administered, and this scarce resource is used.

Regarding the environment, La Laguna ranks 35 out of 77 in a national average, with Gómez Palacio at a level equivalent to the metropolitan and with Torreón with slightly better indicators. Lerdo presents valuations a little inferior to those of the MZLL, while Matamoros in an isolated way would occupy the third last position with levels similar to the Valley of Mexico.

Once having reviewed the economic, political and environmental characteristics of the MZLL, we turn our attention to the natural event that serves as a framework for the realization of the economic experiment that is carried out in this investigation.

Climate Change and the atypical rains of the summer of 2017

During the months of August, September and October of 2017, atypical rains were recorded in the MZLL due to their intensity and duration, since they reached averaging 91.3 mm in one day, almost one third (263mm) that are recorded annually. The affectations were capital letters: dislocation of vehicular traffic, flooding of houses, closing of schools, outbreak of epidemics, labor absenteeism. The city showed not being prepared for this kind of weather events.

Images of the impacts of floods in the MZLL

Image 1 Affection of everyday life



Image 2 Impact of school activities



Image 3 Housing areas affected

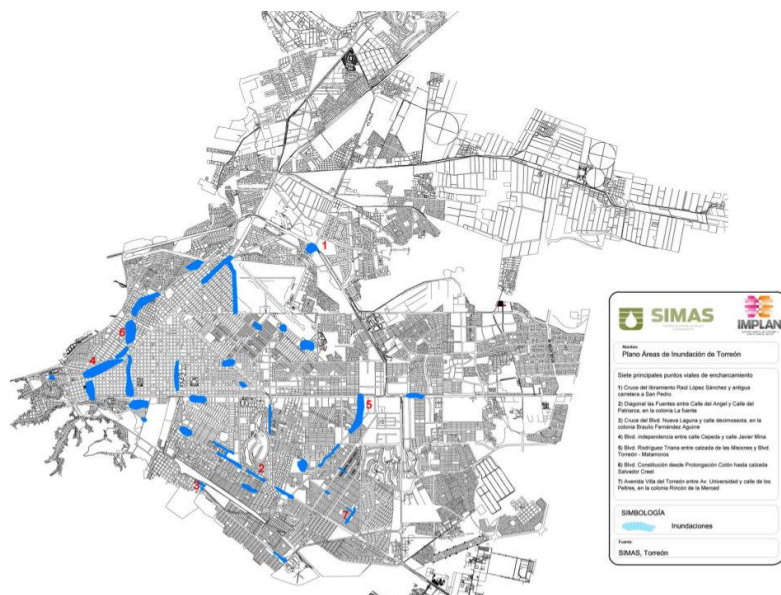


Image 4 economic damages to individuals



The following map shows the areas of the City of Torreon that were impacted by the atypical rains. This affectation served as reference for the field deployment of the polling groups.

Map 3: MZLL flooded zones during the atypic rainfall events taken in 2017



Source: Sistema Municipal de Agua y Saneamiento. Ayuntamiento de Torreón. https://www.google.com.mx/search?hl=es419&tbm=isch&source=hp&biw=1536&bih=759&ei=xY9YW8DaFsGgtQWghanABq&q=INUNDACIONES+TORRE%C3%93N+2017&oq=INUNDACIONES+TORRE%C3%93N+2017&gs_l=img.3...9818.20189.0.21524.25.13.0.11.6.0.409.1822.0j7j1j0j1.9.0...0...1ac.1.64.img..5.14.1766...0j0i30k1j0i24k1j0i8i30k1.0.OnuKu7YieEo#imgrc=Lab2PpuGwNmBxM. Recovered July 25th 2018.

Let us now describe the field work carried out as well as the theoretical framework on which the execution of this type of environmental economic experiments is based.

Materials and methods

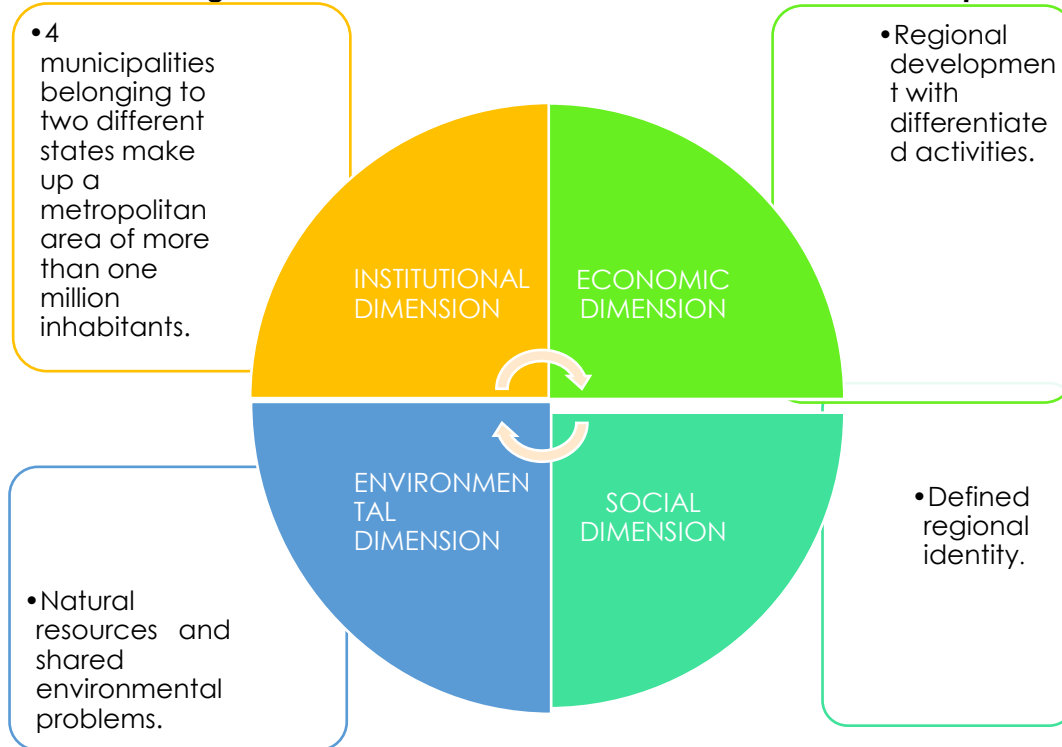
Theoretical framework. – Taking into account the above, a field investigation was carried out under the contingent valuation method (Cummings, Brookshire and Shultze 1986, Mitchell and Carson, 1989, Riera, 1994) in order to get closer to knowing the willingness to pay a "green tax". "(Riera, 1994, OECD, 2011, ECLAC, 2015) aimed at remedying the impact of the waterspouts and establishing the adequate infrastructure to adapt effectively to climate change.

The first level of theoretical approach is based on the concept of sustainable development (United Nations, 1992) with its holistic view of reality. This vision is applied to the regional reality of the MZLL in order to find alternatives that contribute, on the one hand, to strengthen municipal finances, and on the other, to solve strategic environmental problems.

The second level of approach that is proposed is to start from the contingent valuation method (Riera, 1996) the willingness to pay (DAP) is established by the inhabitants of the MZLL, for the establishment of a public trust aimed at building infrastructure pluvial

drainage, that solves the problem of the floods avoiding with this the different negative impacts that they cause among the population.

Diagram 1: Sustainable regional taxation within the framework of sustainable development
Sustainable regional taxation in the framework of sustainable development



Source: Own elaboration

Based on this vision, the logical framework of the problem is elaborated based on the following research questions:

- What are the main polluting activities that affect the health of people and ecosystems in the MZLL?
- What are the environmental and health impacts of the people that come off these activities?
- What are the mechanisms used by the authority to prevent, control or mitigate these activities?
- What have been the results obtained from these measures of the authority?
- What economic instruments can be designed and applied to stop and reverse the regional environmental problems?

- What would be the sectors or activities that would be contemplated for the application of economic instruments that avoid pollution?
- What is the institutional framework that must be developed for the use of green taxes?
- What analysis tools should be used to approach the problem and propose a solution to it?

To advance the response to the research questions posed, the contingent valuation method was used to design a questionnaire to approach the object of study that would allow identifying the following aspects:

- Sensitivity and knowledge about the environmental problems of the community.
- Willingness to pay an environmental contribution.
- Acceptance of an alternative mechanism to collect the citizen contributions to the institutional.

The questionnaire consists of three parts:

- General information of the person interviewed: gender, age, income, education, part of the city where he lives.
- Knowledge of local environmental issues.
- Contingent valuation experiment.

Logistics of information gathering. -

As a first step, we proceeded to review the questionnaire and trained staff on the purpose, content and depth of the questionnaire, as well as the form of behavior that should be assumed once in field work.

As a second step, survey teams were formed, which were assigned to different points in the city of Torreon, seeking to cover the main square of the city:

- Plaza de Armas
- Historical Center
- Commercial walks (Paseo Morelos and Paseo Colón)
- Boulevard Independencia
- Diagonal Reforma
- Boulevard Rodríguez Triana
- Paseo de la Rosita

- Saltillo 400
- Paseo del Tecnológico

Boulevard Revolution

The third step consisted in the elaboration of the questionnaire, which is the following:

QUESTIONNAIRE

FIRST STEP.-

- Greet politely.
- Identify yourself as a student at the Autonomous University of Coahuila.
- Ask if you are willing to answer a BRIEF survey on environmental issues of only 15 questions that will take 5 minutes.

SECOND STEP. -

Once the interview is accepted (choose a place where the sun does not bother), proceed with the GENERAL QUESTIONS.

1 Gender (do not ask, just write down)

1st Male 1b female

2 Age

2nd. -25 to 30 2b 30 to 40 2c 40 to 50 2d 50 to 60 2e over 60

3 Occupation (where you work)

3rd Government 3b services 3c maquiladora 3d commerce 3e independent

4 Maximum level of studies

4th Primary 4b Secondary 4c High School / Technical 4 d University 4e Postgraduate

5 Monthly income (last income, even if you are not currently working)

5th 3 to 5 thousand 5b 5 to 8 thousand 5c 8 to 12 thousand 5d 12 to 20 thousand 5e Above 20 thousand

6- Do you know the amount of your property payment?

6th YES 6b NO (YES, CONTINUED WITH QUESTION 7, DO NOT GO TO QUESTION 8)

7.- What amount do you pay approximately a year?

7th 300 to 500 7b 500 to 750 7c 750 to 1000 7d 1000 to 1500 7e 1500 to 2500 7f More than 2500.

THANK THE ANSWERS AND SHOW THAT YOU WILL BE ASKED ABOUT THE ENVIRONMENT.

8. - How much do you know the concept called SUSTAINABILITY?

8th Nothing 8b Little 8c regular 8d Much 8e Pretty good

9. - In order of importance from 1 to 5 where:

1 NOTHING IMPORTANT,

2 LITTLE IMPORTANT;

3 SOMETHING IMPORTANT;

4 IMPORTANT AND

5 VERY IMPORTANT,

HOW DO YOU QUALIFY THE FOLLOWING ENVIRONMENTAL PROBLEMS?

9th Air pollution

9b Shortage of drinking water

9c Inadequate handling of solid waste (garbage)

9d Lack of green areas

9e Floods of colonies and streets due to heavy rains

9f ASK: Is there another problem that you identify? which? _____

THANK THE ANSWERS AND MENTION THAT YOU WILL BE ASKED ABOUT AN ECONOMIC EXPERIMENT UNDERTAKEN BY THE UNIVERSITY.**APPROACH OF THE EXPERIMENT**

Due to the effects of climate change, it is expected that the MZLL will be impacted by sudden changes in temperature, among which is the occurrence of waterspouts, which as has been seen, cause great harm to people, in their houses and in the puddling of the streets, besides being a focus of infection by the appearance of the mosquito transmitter of dengue.

Faced with this situation, the authorities of the four municipalities of MZLL have agreed to take joint measures to deal with the impacts of climate change.

One of the measures to be taken is the CONSTRUCTION OF PLUVIAL DRAWING, which is expected:

- Avoid colony floods
- Avoid the puddling of streets
- Avoid the appearance of harmful pests
- Allow the use of rainwater to expand the green areas of cities, type the green line.
- Allow the use of rainwater to recharge the water table.

Given the scarcity of resources suffered by the municipalities, the authorities are planning to create a trust independent of the authorities, led by honorable individuals of civil society, which collects from the citizens an environmental contribution that will APPLY EXCLUSIVELY AND DIRECTLY IN THE CONSTRUCTION OF PLUVIAL DRAINAGE. Said contribution will be applied in the property receipt. Once the work is finished, THE ENVIRONMENTAL CONTRIBUTION MENTIONED WILL DISAPPEAR.

ASK IF THE APPROACH IS CLEAR.

Before the previous intention:

10. - Do you support the intention of the authorities to create an environmental trust to solve the problem of flooding of colonies and streets?

10th YES (GO TO QUESTION 12)

10b NO (NO, go to the next question)

11 Why do you think the intention of the authorities is not appropriate?

11th I am not interested in topic 11b I am not affected by floods 11c the authorities transfer the problem to the citizens 11d I do not trust anything the authorities propose 11e Other, which? _____ THE INTERVIEW FINISHES, THANKS AND ANSWERS ARE APPRECIATED

12 - For the solution of the problem of the floods of colonies and streets Would you be willing to give a contribution to the environmental trust each year by means of an extra amount in your property receipt?

12th YES 12 B NO (YES YOU GO TO 13, NO, THE INTERVIEW ENDS, THANK ATTENTION AND ANSWERS;)

13. - What amount would you be willing to contribute annually:? SAY THE QUANTITIES ONE BY ONE WAITING FOR THE ANSWER BEFORE SAYING THE FOLLOWING. AT THE FIRST YES, RECORD THE ANSWER.

13th 500 pesos 13b 450 13c 350 13d 300 13e Other quantity How much? _____

THANK THE RESPONSES VERY CAREFULLY

Name and registration of the interviewer:

I will now turn to the mathematical approach on which the statistical exercise carried out in the MZLL was based

Mathematical formalization

1.- Universe to be surveyed: Employed population in Torreón: 272,449

Equation 1

$$n = \frac{N * Z_{\alpha}^2 * p * q}{d^2 * (N - 1) + Z_{\alpha}^2 * p * q}$$

Where:

N = Total population

Z_{α} = 1.96 squared

p = expected proportion (5% = 0.05)

q = 1- p

d = accuracy

N = 272,449

Z_{α} = 1.96 squared

p = 5% = 0.05%

q = 0.95

d = 5%

Total population to survey: 383

A total of 420 observations were made and validated, obtaining a database with 400 observations.

The result of the information gathering is shown below.

RESULTS

- 1.- In order to eliminate the gender bias, 418 observations were made, of which 209 corresponded to women and 209 to men, whose average age was 46 years.
- 2.- 37% of the interviewees have a high school level and 35% have a university degree; only 23% said they had basic level studies.
3. - 32% of the informants reported income between 3 and 5 thousand pesos per month (250 US dollars); 29% income between 5 and 8 thousand pesos per month (400 dollars), 25% has income between 8 to 12 thousand pesos per month (600 dollars); 11% reported income between 12 to 20 thousand pesos per month (1,000 dollars); and only 2% reported income above 20 thousand pesos per month.
4. - Of the people who acknowledged making the property tax payment and knowing its amount, 27% placed it between 300 to 500 pesos per year (25 dollars), 37% placed it between 500 to 750 pesos (37.5 dollars); 19% placed their payment between 750 to 1000 pesos (50 dollars); only 10% registered their property tax payment between 1,000 and 1,500 pesos (75 dollars).

5. - Regarding the knowledge of the meaning of the word sustainability, 11% said that they did not know it; 26% know little; 39% said they knew it regularly; 18% know it a lot; only 3% know quite well the meaning of sustainability.

6. - About the environmental problems, 51% affirmed that the problem of floods is very important; while 67% declared to have been affected by the floods directly.

7. - With reference to the convenience of creating a trust in charge of building rainwater drainage infrastructure, 61% agreed to the creation of such a trust, while 39% declared against.

8. Regarding the reasons for which it opposes the creation of the trust, 37% said that this is because the authorities transfer the problem to the citizens; 39% said they do not trust anything the authorities propose; 16% did not feel identified with the problem.

9. - One of the key questions, would you contribute to the trust? 55% said no, and 45% said yes. This result, from my point of view, is highly positive because, in the context of economic deprivation and lack of confidence in the authorities, people express themselves favorably to an action that will remedy a problem, assuming an economic cost.

10. - Regarding the amount that would be willing to pay to contribute to the trust, 41% expressed to make a payment for 300 pesos per year (15 dollars); 21% for 350 pesos (17.5 dollars); 4% for 450 pesos (22.5 dollars); 4% for 500 pesos (25 dollars) and 25% were undecided in the amount to contribute.

The ***dynamic crossings*** between the different reagents used yielded interesting results, such as those detailed below.

11.- No matter the degree of knowledge of the word sustainability, the interviewees expressed themselves in favor of the creation of the environmental trust; in the same sense, the interviewee's age is not relevant to accept such a trust.

12.- Among the trust acceptors, regardless of the degree of knowledge of the word sustainability, the interviewees expressed in favor of the creation of the environmental trust; in the same sense, the interviewee's age is not relevant to accept such a trust.

13. - A clear relationship was identified between the level of schooling and the willingness to pay, where from the high school level, the acceptance to pay increases, until exceeding the post-graduate level to the refusal to pay. At the extremes of lower percentage participation the change is appreciated, since, while at the primary level, the refusal to change was a majority, at the graduate level, the relationship becomes favorable for payment.

14. - Regarding the reported income, the most indicated payment range was between 300 and 350 pesos (17.5 dollars), which is interesting, since it can represent 100% of the property tax payment in a good percentage of the population and in another not less

important, 50% of the payment of said tax, something that, if it were raised directly, would cause a great social opposition.

15. - The willingness to pay, according to the areas affected by the floods, showed that those colonies that suffered flooding in their homes or commercial premises were more likely to accept payment than those in which the floods were suffered in the avenues and streets.

Conclusions

Some general reflections and other particular ones arise from the developed field work. I will begin by describing those of a general character.

In General:

1.-Vulnerability and adaptation to climate change are issues that are inextricably linked *vis a vis* the development model that a country has. A very interesting discussion on this topic can be found in: *The elephant in the room: Capitalism and global environmental change* (Global Environmental Change 2011) article that shows the different facets of the in-depth analysis of the relationship between capitalist model and change climate.

2.-Thus, a possible origin of the phenomenon under study in the case of Mexico, would be found in the economic model followed from the decade of the eighties of the last century, when there is a great turnaround in an economy based primarily on the model of import substitution, towards an open and globalized economy (Moreno_Brid and Ross 2010, Ortíz Wadgyamar 2010), whose results 25 years later, were not the ones that defended the then new paradigm of Mexican development, which hypothetically, would make our country in the face of regional alliances in process (Salas-Porras and Uscanga 2008).

Arguing the above, according to the measurement of poverty made by the National Council for the Evaluation of Social Policy (CONEVAL), in 2008, all the states of the country had a Gini coefficient above that registered in 1987; 11 entities were between 0.42 and 0.48; 9 did it between 0.48 and 0.50; while 12 were between 0.50 and 0.56. (CONEVAL, maps of poverty in Mexico, 2008).

In information for 2012, based on the General Population Census carried out by INEGI, CONEVAL (2013) reveals that the number of Mexicans living in poverty increased from 52.8 million in 2010 to 53.3 million in 2012, and extreme poverty from 13 million people in 2010 to 11.5 in 2012, with 1003 municipalities in the country having 75% or more of their population living in poverty, and 190 municipalities in which they concentrate half of the population in this situation. (CONEVAL 2010).

This social panorama really exists in our country, acquires even more importance, in the light of the studies on the possible impacts that climate change will have (from the growth

scenarios of the world economy raised by the IPCC) in various productive sectors from Mexico.

Galindo (2009), in his study *Economics and Climate Change in Mexico*, synthesizes, that both governmental and social inaction can lead to costs close to 12% of GDP (discount rate of 0.05%); as discrete measures, (discount rate of 2%) this same cost would decrease to 6.95%; what is most significant is that even taking major adaptation actions (discount rate of 4%) the expected cost of the impacts of climate change as a percentage of GDP, would reach 3.71% in scenarios by 2050.

ECLAC (2010) also takes stock of the possible costs of the impacts of climate change on our region. Its results show strong figures: Central America, under different scenarios, would have a variation of affectation as a percentage of its GDP, between 70%, with a discount rate of 0.5%; and 10% if one of 4% is applied; For its part, Chile and Uruguay will lose one percentage point of their GDP each year until 2100.

The main characteristics that these costs acquire, following ECLAC are:

- Significant and heterogeneous: The costs are significant but they differ greatly according to the sector, economic agent, region or climate.
- Short-term losers and winners: Costs will increase as the temperature increases. However, in the short term, there will be regions of the continent that will experience growth, since this increase in temperature will expand the area of cultivation. In contrast, in those areas with low incomes, which are less able to adapt and prevent, the economic costs could be significant as a result of extreme weather events even in the short term.
- Non-linear and irreversible: Costs will increase unevenly, with specific borders that, once exceeded, will cause irreparable damage, such as the case of biodiversity.
- Dependents of climate scenarios: Economic costs are dependent on climate change projections. Evidence shows that, in the absence of mitigation, the economic costs of climate change are usually higher than any internationally coordinated mitigation process. Although this is not necessarily maintained for all regions (p. 19).

This is based on the climate scenarios methodology, which, as we have seen, corresponds to the vision that is most widely disseminated by the IPCC. Moreover, if we take these previous projections as the basis for our analysis of the costs of climate change, but from the conditions of gradual deterioration suffered by the natural capital of the country, thanks to the prevailing development model, the outlook is significantly complicated.

3. -In addition to the technical aspects required to present a strategy or public policy, the literature that studies the forms and procedures of adaptation, points out that while government plans have coherence and objectivity, they should be sought between society elements of an aspirational nature, that contain motivations and socio - political objectives,

teleological legitimacy, legitimacy of procedure and rules on decisions that are made (Haddad, 2005), so that the actions that are undertaken have a greater chance of success. Thus, it is convenient to reflect on whether adaptation to climate change can be done efficiently without the conscious participation of society.

Therefore, from my perspective, social cohesion is a priority issue to be considered, so that it becomes the platform on which to build public policy strategies in terms of development and in particular adaptation to climate change.

In an excellent analysis about the importance of social cohesion in the strategy of public policies in the face of climate change, Vega-López (2010:15) refers to this aspect, noting:

"In times of climate change, the weakness, fragility or lack of social cohesion becomes a key analytical piece to complete the diagnoses about the set of social and economic vulnerabilities that any country, region, city or place faces in the face of climatic threats of origin anthropogenic and before current public policies, conventional, inertial or adequate and effective for the times "

4. -Other elements also to consider for an effective action of adaptation to climate change can be the so-called social barriers to adaptation (Jones and Boyd, 2011) where cognitive, normative and institutional aspects converge. To these barriers are added, not least, skepticism and social uncertainty to climate change (Freudenburg, WR Musell, V 2010; Shwom R. Bidwell, D. Dan, A. Dietz, T. 2010, Whitmarsh, 2011; Atker, 2012; Krishnamurthy, 2011).

In this same discursive line, the way in which social actors approach problem management stands out (Tompkins, and Eakin, 2012; Hobson, 2011). This highlights the social capital, whose existence is essential to have a greater scope in government actions that are undertaken in terms of adaptation (Pelling and High 2005).

5. -To the above considerations, we must add the weakness of state governments to assume their responsibility as generators of better conditions to address vulnerability to climate change. Thus, despite the fact that there seems to be a favorable global and national context to carry out the required adaptation measures, the level of the environmental budget managed by the states of the country indicates that the issue is of very low interest. In a recent study conducted for Mexico by the United States Agency for International Development (USAID, 2012), the Green Budget Index (IPV) was designed, showing the spending by the states in the environmental issue. The average registered by the 32 states is 1.30% of the total expenditure, among which stands out the maximum of 4.57% of Puebla and the minimum of 0.0 of Queretaro. To the by itself disappointing low percentage, the marked contrast in the interest of the states in the subject is added, as exhibited by the existing gap between the maximum and the minimum mentioned above.

Following again to INEGI (2013), environmental spending (remediation, prevention, administration and research and development,) as a percentage of GDP reaches levels whose maximum is 1.0%, falling even to 0.9% in the most recent measurement made in 2011.

6. -At a more particular level, the atypical hydrometeorological events that occurred in the MZLL in 2017, despite the fact that the material damages were not high, if on the contrary they showed the enormous vulnerability that this metropolitan area has to the impacts of climate change, what drives the design of efficient adaptation mechanisms. It is not a secret, every measure that is undertaken has a cost. For this reason, designing tools of a fiscal nature to count on surplus resources is a good alternative for municipal governments, which are the last in the collection of resources, but the first ones to face environmental or all kinds of problems.

Faced with this need for greater resources, it is not only important, but strategic to design and propose a contributory scheme aimed at adapting to climate change in a clear, transparent and methodologically sound manner, so that the population can see the cost - benefit expeditiously.

The Organization for Economic Cooperation and Development (OECD, 2011) establishes 9 aspects to consider in the design of a green tax, here I will highlight 5 of them:

- *Go to a specific point of environmental pollution to be solved, or to some contaminating behavior of a particular agent.*

This first step is of the utmost importance, since it is from here that the environmental damage to be corrected is precisely identified, and in its case the polluter who causes it, thus avoiding generalizations and lack of definition that may cause little transparency about the purpose of the green tax since its inception.

- *The amount of the green tax should ideally correspond to the environmental damage caused by a polluter (or by climate change).*

The chrematistic valuation of an environmental damage is undoubtedly a challenge facing the economy, since it must consider not only the market value of the natural good, but the service that it provides to the chain of life. Therefore, the authorities that promote the tax as well as the corresponding legislative body must have very detailed technical studies that approximate as close as possible the amount of the tax with the correction of the negative externality that is to be eliminated.

- *The tax must be credible and its rate predictable in order to motivate environmental improvements.*

The green tax must have a clear environmental and social objective: to remedy environmental damage and / or change polluting attitudes. Therefore, a green tax that is

not cost-efficient is unthinkable, since that can lead to the ruin of the productive activity where the tax is focused; it must also be realistic according to the technical-scientific diagnosis of the damage, to see if it is possible to eliminate, mitigate or repair it environmentally.

- *The income generated by the green tax should be directed exclusively towards the repair of the identified environmental damage.*

Given the weakness of income to public finances, it is very tempting to use the resources obtained through a green tax, for other purposes determined by the authority. In this regard, the green tax has the characteristic that the income received by its implementation, has already a previously established objective, so any deviation to the above distorts the purpose of the tax, prompting *pari pasu* the non-correction of the environmental damage and social disbelief before the action of the authority.

- *Clear communication is vital to obtain public acceptance of the green tax.*

The social looting and rioting that took place in various parts of the country during the first week of 2017 are a sign of the government's lack of effective communication about a public policy that was undertaken (release the price of gasoline). No sector of society supported such a policy, and even more, almost no social sector was aware of the objective and significance of the release of the price of gasoline and diesel that occurred from the first day of the year.

The liberalization of the price of gasoline is a fact little understood and less supported by society. Independently of many factors underlying the social mood, the government did not clearly and adequately state *ex ante* or *ex post* the reasons and objectives of its decision, provoking generalized repudiation of the decision.

Thus, if any tax, tribute, tariff or measure known to be collected must be perfectly explained to the citizenry before putting it into operation, the green tax should be even more so.

In Particular:

- 1.- The contingent valuation method was effective to know the feelings of the people regarding a certain problem, in this case of an environmental nature.
2. - Notwithstanding the situation of economic hardship suffered by Mexico, the investigation showed that, when there is clarity in the destination of the extraordinary funds that citizens are asked to solve an environmental problem, the response has a high percentage of acceptance.
3. - Effective adaptation to the impacts of climate change implies building new forms of relationship between society and government, especially when it comes to generating resources to carry out adaptation actions that prevent catastrophic damage. In this sense,

knowing the disposition of the citizens before an increase in taxes is key to see the viability of the project.

4. - The dynamics of the urban development of Mexico and the creation of metropolitan zones that, as in the case of study, have particular political-administrative characteristics, forces to design and carry out more flexible forms of organization, tending to allow metropolitan policies that serve as effective way to face the challenge of adaptation to climate change.

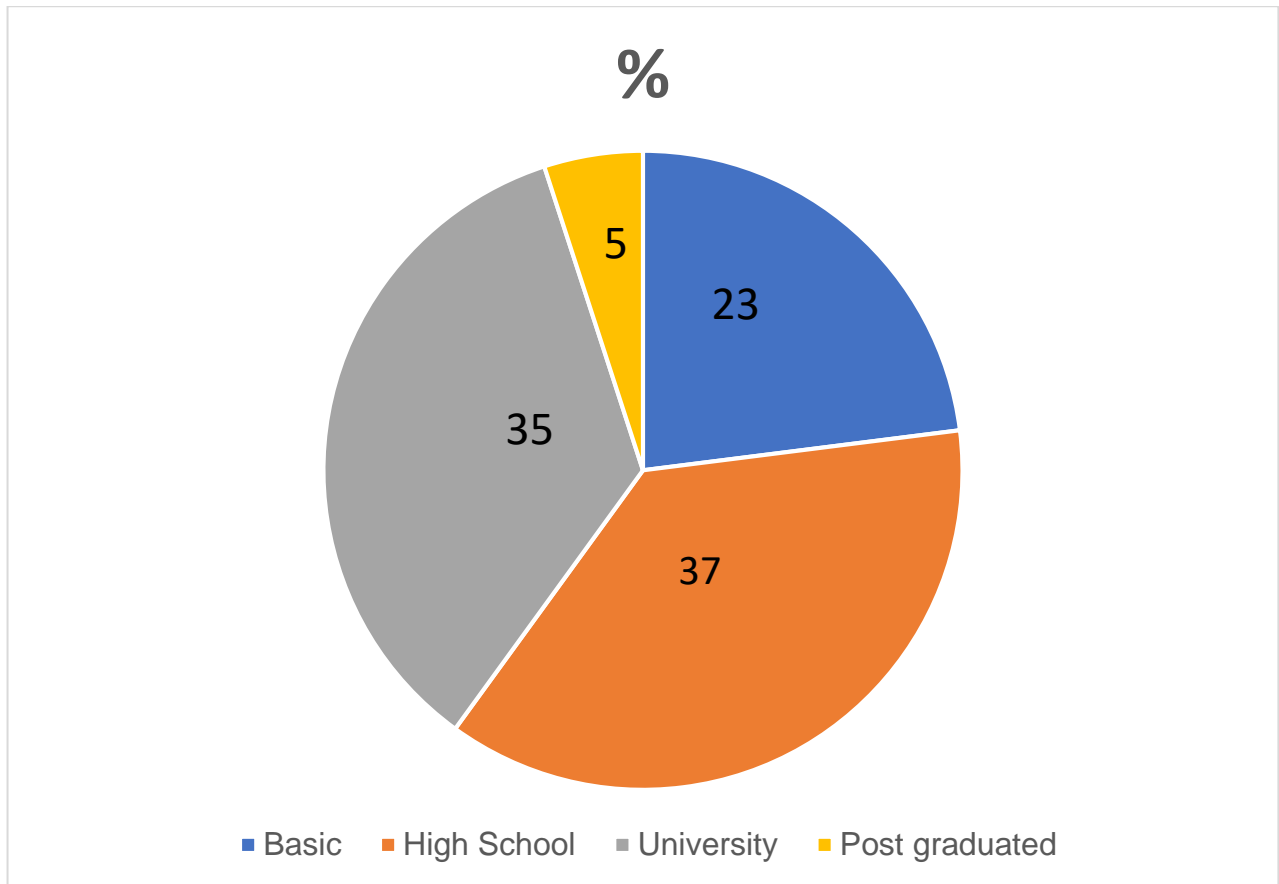
5. - Education plays a strategic role for the advancement of sustainability. The research showed that to the extent that the educational level was higher, the willingness to contribute to the trust was greater in relation to the refusal to do so. Notwithstanding the above, the percentage of refusal is high, despite having a university level, which makes one think that it is necessary to strengthen environmental education in universities in all careers and at all levels.

The people of Mexico took a historic step in the presidential elections held in July of this year. Regardless of the political aspects, it undoubtedly highlights the mandate given to the new government to initiate a profound change in the institutions and forms of governance, where the schemes inherited from the old hegemonic regime must be replaced by new forms of social organization that make effective the desire of the population to build an efficient and equitable society, with close proximity to the environmental aspects and aware of the great responsibility of undertaking adaptation actions in the face of climate change in order to reduce the vulnerability now existing, to give the population a more viable life horizon and of higher quality.

ANNEX: GRAPHICS OF THE MAIN RESULTS OBTAINED

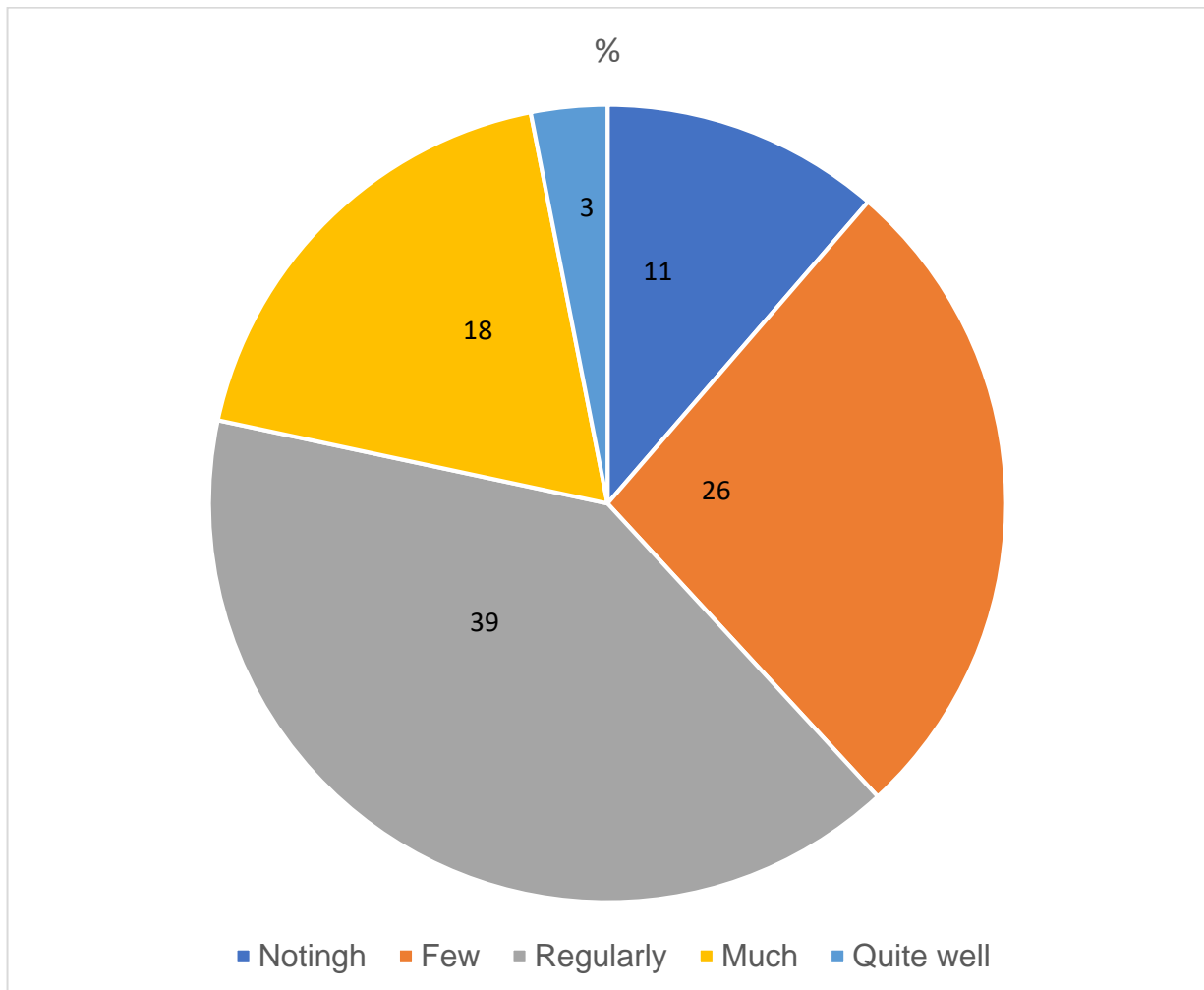
418 observations were made, of which 209 corresponded to women and 209 to men, whose average age was 46 years.

37% of the interviewees have a high school level and 35% have a university degree; only 23% said they had basic level studies.

Graphic 1 Level of education of the interviewees %

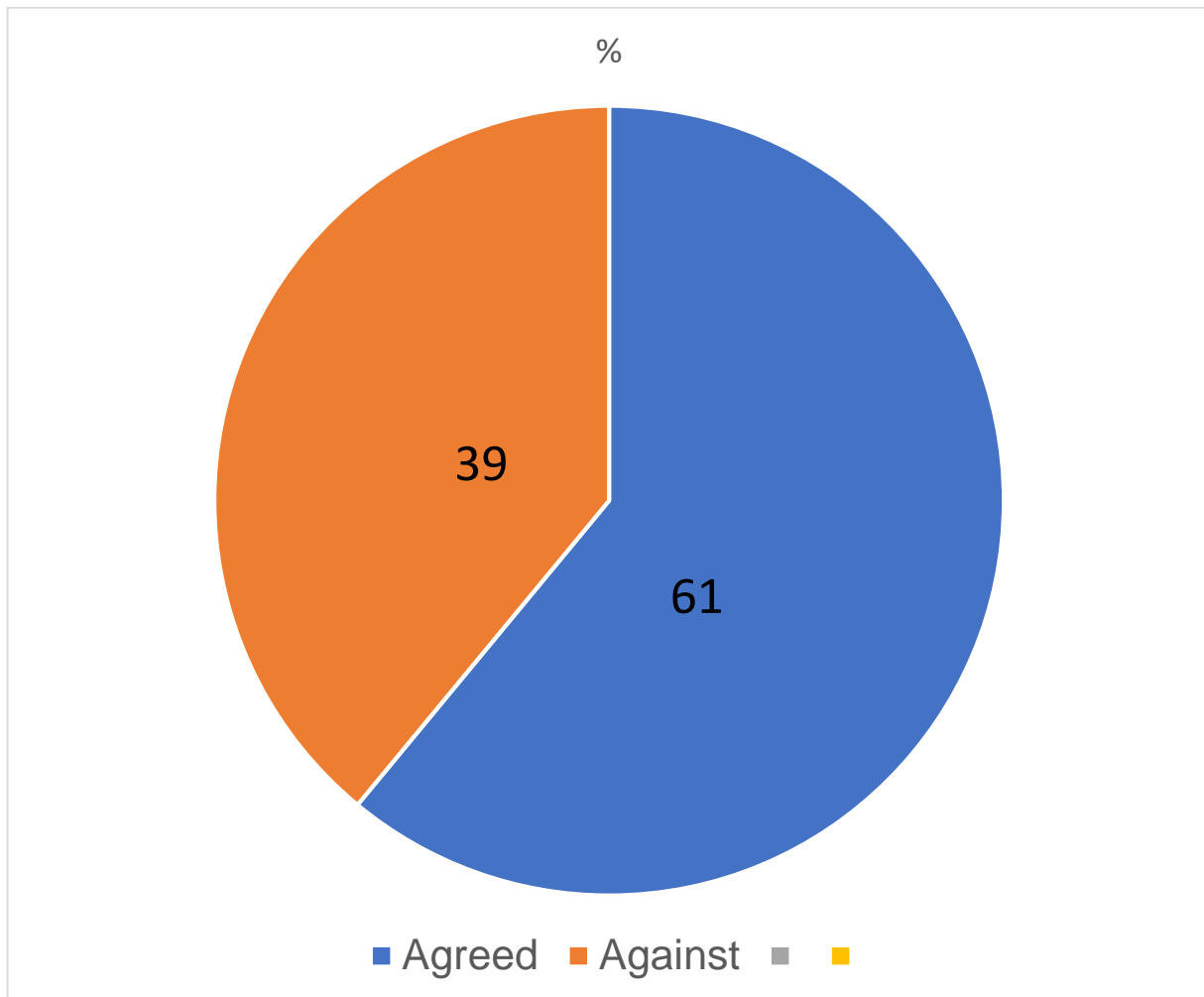
Commentary: We sought to find some relationship between the academic level and willingness to pay.

Regarding the knowledge of the meaning of the word sustainability, 11% said that they did not know it; 26% know little; 39% said they knew it regularly; 18% know it a lot; only 3% know quite well the meaning of sustainability

Graphic 2 Meaning of sustainability

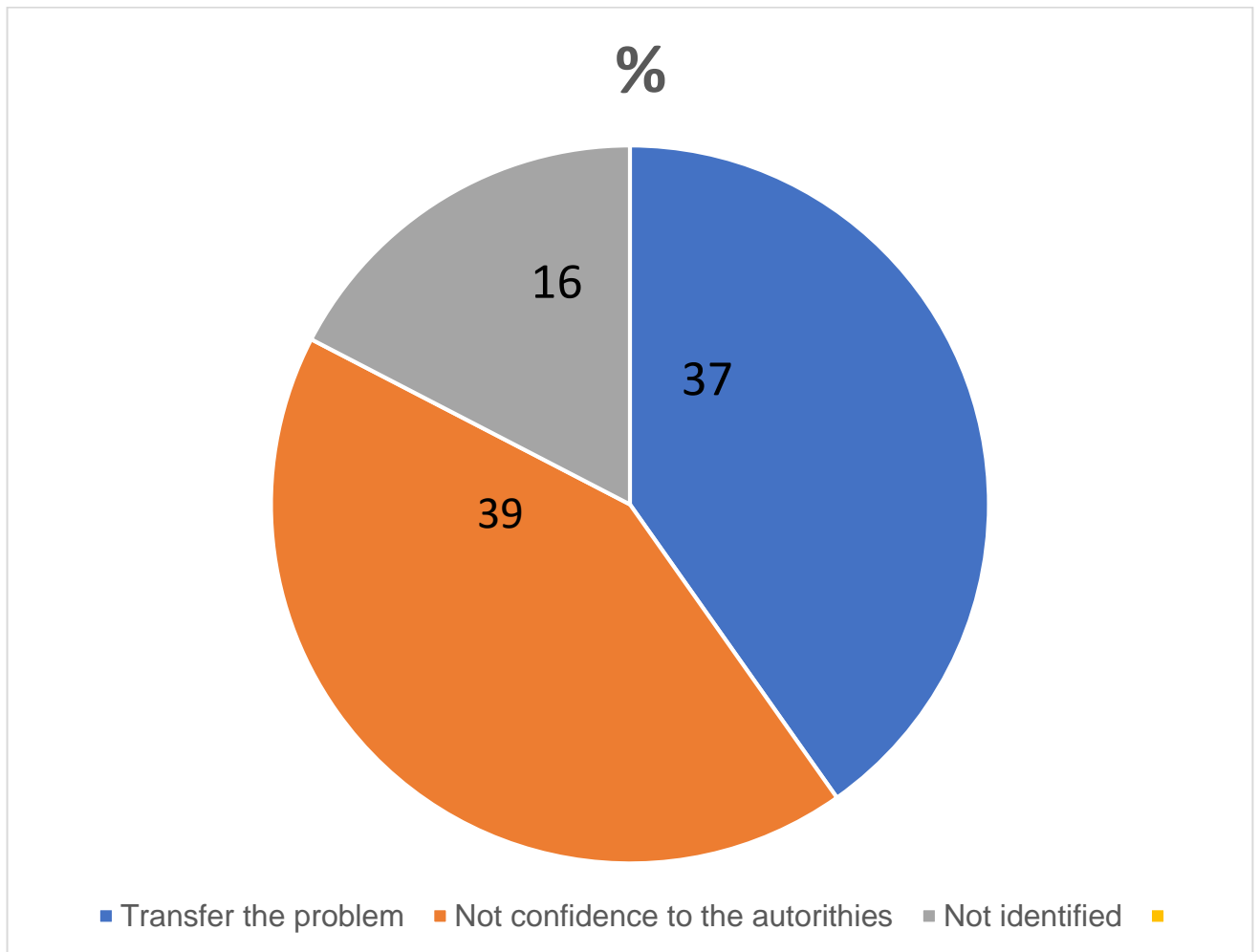
Commentary: We sought to find background and information in the interviewees about environmental problems in order to know the basis of ecological awareness present in them.

- With reference to the convenience of creating a trust in charge of building rainwater drainage infrastructure, 61% agreed to the creation of such a trust, while 39% declared against.

Graphic 3 Convenience of creating an environmental trust

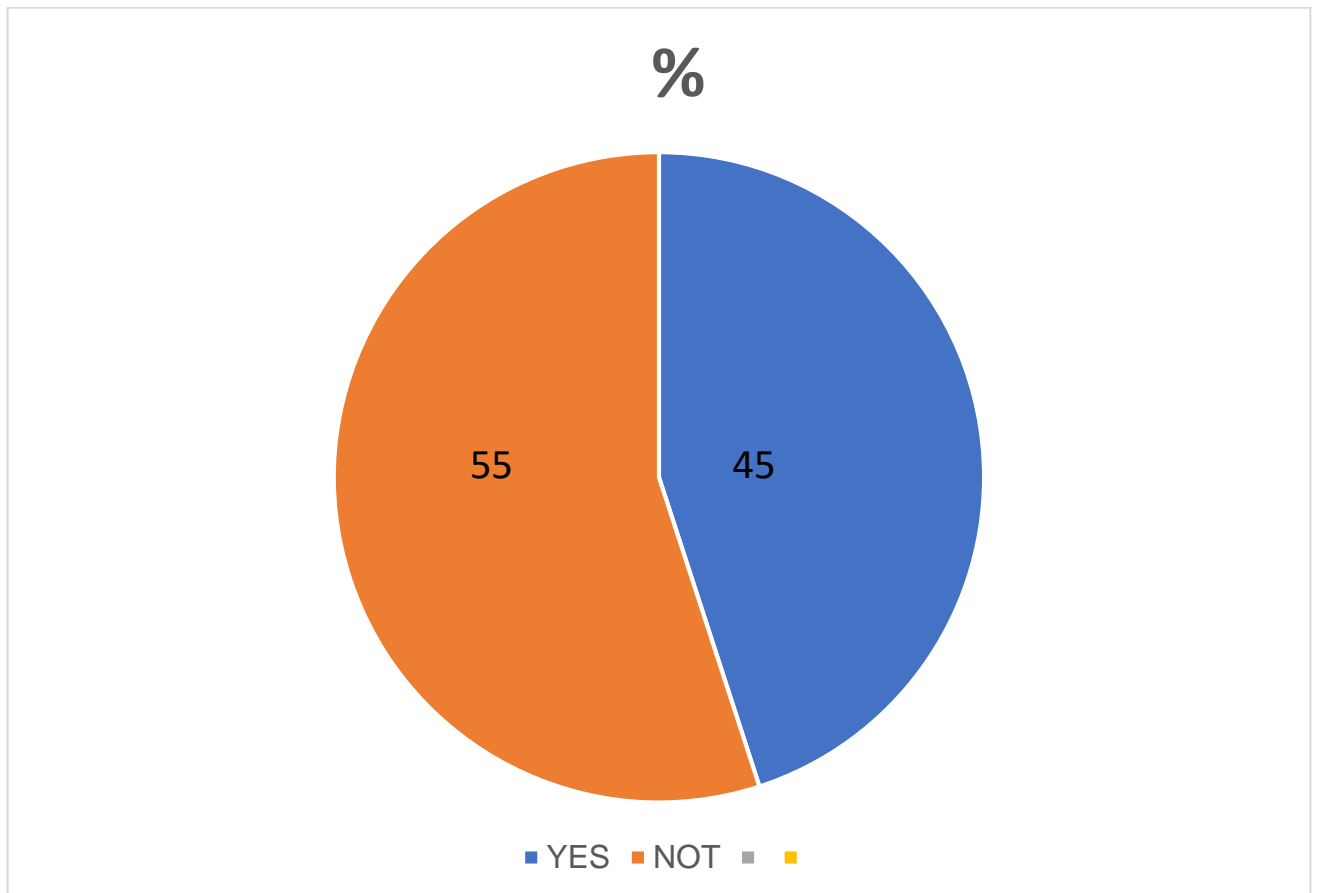
Commentary: This variable was designed in order to be able to verify the strength of the willingness to pay once the amount willing to cover was asked

Regarding the reasons for which it opposes the creation of the trust, 37% said that this is because the authorities transfer the problem to the citizens; 39% said they do not trust anything the authorities propose; 16% did not feel identified with the problem.

Graphic 4 Reasons to Opposite to create the environmental trust

Commentary: This question seeks to know the reasons for the rejection of the creation of the trust in order to know the existence of reasons beyond the strictly economic.

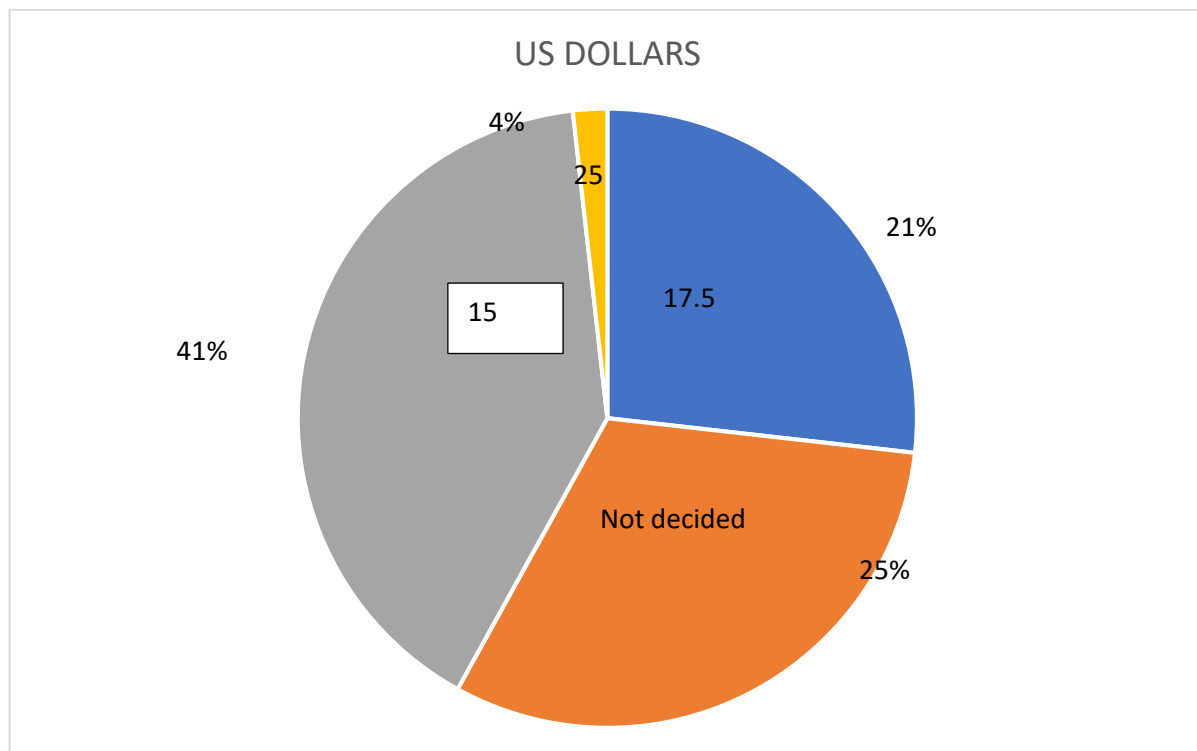
One of the key questions, would you contribute to the trust? 55% said no, and 45% said yes.

Graphic 5 Would you contribute to the environmental trust?

Commentary: This question tries to reaffirm the position of the interviewee regarding the existence of the trust once it is asked to contribute to it. The percentage of acceptance drops from that reached with the acceptance of the creation of the trust, which stood at 61%, however, it is considered a high level of participation, taking into account the unusualness of the proposal to increase the property tax payment, and the context of distrust shown by the people before the actions undertaken by the authorities.

Regarding the amount that would be willing to pay to contribute to the trust, 41% expressed to make a payment for 300 pesos per year (15 dollars); 21% for 350 pesos (17.5 dollars); 4% for 450 pesos (22.5 dollars); 4% for 500 pesos (25 dollars) and 25% were undecided in the amount to contribute.

Graphic 6 Amount be willing to pay to the environmental trust



Commentary: It was relevant to discover that the accepted majority amount was between 15 and 17.5 dollars, an amount that represents approximately 50% of the average value of the property tax that is covered annually, what tells us the willingness of people to collaborate in the solution of environmental problems, which goes beyond a position of conscience, to become a payment action, which in this case is not negligible taking into account the context of the existing property tax.

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Geographical location of Region Lagunera
https://www.google.com.mx/search?hl=es419&tbn=isch&source=hp&biw=1536&bih=710&ei=tsVYW-vSD4HmtQWjwKf4Ag&q=comarca+lagunera+mexico&oq=COMARCA+LAGUNERA&gs_l=img.1.4.017j0i30k1i13.1280.3739.0.17994.16.8.0.3.3.0.537.1483.4-1j2.3.0....0...1ac.1.64.img..10.6.1534....0.qqA0-xcwElc#imgrc=mkaMp2z8wwq4FM: Recoverd july 25Th 2018.

Metropolitan zone of La Laguna

https://www.google.com.mx/search?hl=es419&biw=1536&bih=710&tbn=isch&sa=1&ei=y8VYW8_eJIW6sQWtyrKIAg&q=mapa+de+la+zona+metropolitana+de+La+Laguna&oq=mapa+de+la+zona+metropolitana+de+La+Laguna&gs_l=img.3...326974.343198.0.344134.42.30.0.12.12.0.315.4450.0j18j5j1.24.0....0...1c.1.64.img..7.23.2514...0j0i67k1j0i10k1j0i30k1.0.sx6g7UzkXLM#imgrc=SP1Oa77kMMSJtM: Recoverd july 25Th 2018.

MZLL flooded zones during the atypic rainfall events taken in 2017

https://www.google.com.mx/search?hl=es419&tbm=isch&source=hp&biw=1536&bih=759&ei=xY9YW8DaFsGgtQWGhanABg&q=INUNDACIONES+TORRE%C3%93N+2017&oq=INUNDACIONES+TORRE%C3%93N+2017&gs_l=img.3...9818.20189.0.21524.25.13.0.11.6.0.409.1822.0j7j1j0j1.9.0...0...1ac.1.64.img..5.14.1766...0j0i30k1j0i24k1j0i8i30k1.0.OnuKu7YjeEo#imgrc=Lab2PpuGwNmBxM. Recoverd july 25Th 2018.

Images: Floods in the MZLL

Source:

https://www.google.com.mx/search?hl=es419&tbm=isch&source=hp&biw=1536&bih=759&ei=1qVbW_CQBsjBjwTT4l34Aw&q=inundaciones+en+torreon+2017&oq=inundaciones+en+torre&gs_l=img.1.3.0i30k1j0i24k1l4.1522.7045.0.11861.21.12.0.9.9.0.257.2205.0j7j4.11.0...0...1ac.1.64.img..1.20.2343...0.0.u0DEIVV4olA