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ENVIRONMENTAL PERCEPTION OF SOLID WASTE MANAGEMENT IN THE MUNICIPALITIES OF PÁTZCUARO REGION, MEXICO

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Abstract

Patzcuaro Lake, placed in the lacustrine zone of Michoacán (central México), has four municipalities around its shoreline, and is an important tourist attraction in the region. Because the area is predominantly rural it lacks many efficient public services, amount them adequate management of solid wastes that is reflected in the insufficient collection services and lack of landfills in the area. The object of this research was to determine the local environmental perception of the current solid waste management in the area. A survey that included economic, social, demographic and environmental aspects was carried out in nine villages of the region. Eleven variables were significantly related, using a chi square test. Seventy percent of the interviewed population belonged to the female gender. Concerning income and dwelling type, it was revealed that there was no direct relation. The presence and uses of patios (courtyards), as reported by questionnaires, revealed that these continue to be alternative places for organic wastes generated in the household. Obtained answers disclosed that, when declaring the problem that domestic solid waste generates or the choice of refuse disposal, genders tend to agree. Results suggest that the area has a specific environmental perception, as confirmed by the analysis of significantly related variables. This last statement is a key in taking into account the implementation of solid waste management programs. It is evident that the pure application of a program developed for an urban area, will fail in this lacustrine region.

Key words: environmental, Mexico, perception, solid, waste, management

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1. Introduction

1.1. Environmental behavior and attitudes

Environmental perception is understood as the relationship human beings have with the environment. This relationship determines the attitudes of the people in favor of or against the environment (Leung and Rice, 2002; Taboada-González etal., 2011). The analysis of environmental perception has been approached by means of environmental behavior (Corraliza and Berenguer, 2000) and environmental beliefs or values (Stern, 1992). However, when analyzing the literature it was found that the relationship is not so simple, as there are several factors that influence pro-environmental behavior. Therefore, it is important to understand which factors promote or inhibit environmental behavior, for example, values and beliefs (Bardi and Schratz, 2003, De Groot and Steg, 2007; Snelgar, 2006), cultural values (Deng et al., 2006); environmental activism (Dono et al., 2010; Fielding et al., 2008).

Regarding the analysis of environmental behavior, variables such as the altruistic behaviorhave been used, i.e., recycling, saving

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energy or other activities based on personal rules and feelings of moral obligation (Brehm and Eisenhauer, 2006; Thanh et al., 2012).

On the other hand, to analyze environmental beliefs or values, situations such as the social dilemma in the usage of common resources and the theory on the expected value of resources have been used (Gutiérrez, 1996). According to Portinga et al. (2004) it is widely accepted that what individuals do in their life time has a direct connection to their beliefs and values. Thus, environmental attitudes and behaviors are frequently linked to those personal values.Related to this, attitudes are favorable or unfavorable feelings inspired by an object or situation. Attitudes are therefore related to social benefits such as environmental protection. However, self-efficacy is also important, because it involves the extent that an individual believes how much his actions will matter (Ewerth et al., 2005).

Therefore, environmental attitudes are understood as favorable or unfavorable feelings towards some feature of the physical environment or a problem related to it. On account of this, environmental attitudes are the basis of many individual decisions. Attitudes have been widely studied through cultural (values) and psychological (beliefs) factors (Widegren, 1998).

1.2. Attitudes to solid waste management

Some authors have reported that there is a wide variability in results when analyzing variables that motivate solid waste management and recycling (Begun and Pereira, 2008; Vencatasawmy et al., 2000). It is not uncommon that recycling programs are based on overall indexes, but disregarding precise differences and motivations of local or regional idiosyncrasies.

Even though recycling encompasses several advantages such as economical rewards, sustainable use of natural resources and extended life of landfills (Hasnain et al., 2005; Scheinberg et al., 2011), the later has not been well established with respect to formal recycling in Latin America. It is therefore of paramount importance to learn the environmental perception of regions prior to the implementation of solid waste management programs.

Traditionally in rural areas of developing countries, solid waste management still surpasses the technical capabilities of small municipalities. In addition, landfilling cost is high and the adequate combustion of solid waste is virtually nonexistent.

This situation appraises inadequate solid waste collection and disposal practices. Thus, the absence of suitable facilities (equipment and infrastructure); the underestimates of waste generation rates, the inadequate management and technical skills, along with improper route planning are largely responsible for poor collection of municipal solid wastes (Bolaane and Ali, 2004; Hazra and Goel, 2009).

1.3. Solid waste management in the study area

The Pátzcuaro region comprises four municipalities, Pátzcuaro, Quiroga, Erongaricuaro, and Tzintzuntzan (Table 1 and Fig. 1). The area is lacustrine and rural, and therefore presents particular features, such as (1) geographical barriers, (2) economical restrictions in the form of low federal budget, (3) cultural (very low education level and the use of an indigenous language other than Spanish) and (4) social conditions (elevated migration rates); causing this region to be different from other regions of the Michoacan state.

Pátzcuaro is the only municipality that has a landfill that complies with the criteria of the Mexican environmental legislation; 47 tons of wastes are produced daily and this amount increases about ten percent on weekends and holidays. Quiroga, on the other hand, has an open dump located three kilometersfrom the city, the collection service is deficient and illegal dumps are rampant.

This municipality produces 23 tons of solid waste daily and this amount increases one ton in weekends and holidays. Tzintzuntzan is the municipality that produces the least amount of wastes, two tons per day, which are disposed in a dump. The municipality of Erongarícuaro produces four tons daily which are disposedin the landfill of Pátzcuaro. The total amount of wastes produced per day in the area of study is 76 tons.

Table 1. Population data of the studied area

Municipality	*Population*	*Dwellings*	*Average of inhabitants per dwelling*
Patzcuaro	87,794	20,466	4.3
Quiroga	25,592	6,213	4.1
Erongaricuaro	14,555	3,448	4.2
Tzintzuntzan	13,556	3,173	4.3
Total/average	141,497	33,300	4.2

Source: XIII General Population and Household Census INEGI, 2010)

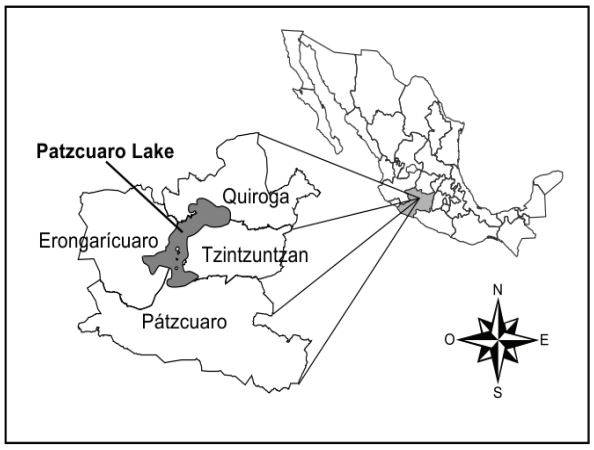

Fig. 1. Location of the study area

Solid waste management in the area is characterized by low frequency and poor coverage of the area. Domestic waste is collected weekly and only in the main streets of villages, because those are the accessible roadsfor vehicles.

During the last decade, municipal solid waste programs in the region have been designed by personnel with limited knowledge in the solid waste field. The preceding aspect, together with other political, economical and technical issues, has contributed to the failure of all implemented programs. This research was carried out in localities of the Pátzcuaro basin to establish the perceptionthat the inhabitants have with respect to the generation and management of solid waste.

2. Material and methods

2.1. Questionnaire form design

The environmental perception and solid waste management was established by applying a face to face survey to 1,243 residents, in the same number of dwellings. The questionnaire contained 28 multiple-choice questions. The design of the questionnaire is based on six categories: 1) Socio-demographics: number of dwellers, sex, age and education level, 2) Household economy: ownership regime, income, existence/type of bathroom, 3) Waste management at the household: existence of a courtyard (*patio*) in the household; frequency of the household's waste disposal; 4) Municipal solid waste collection: frequency of collection and agency providing the service; 5) Perception: problems of solid waste at the household and in the community, assessment of the type of problem that solid waste originate, and the responsibility required to solve the problem; 6) Attitudes: to separate, reuse and recycle, participation in some program on minimizing solid waste.

2.2. Methodology of questionnaire application

The total dwellings in the study area of interest were 33,300 (INEGI, 2010). The number of samples was determined by the Stein's procedure and the samples sites were chosen by socioeconomic level following the classification of the Mexican census bureau (INEGI by its Spanish acronym). According to Stein, the number of required samples was 1095, in order to attain a 90 percent confidence level.

Questionnaires were applied face to face, according to acceptance from the individual answering the door. Twelve undergraduate biologists were trained to apply the questionnaires, in order to avoid leading the interviewed when answering, and to be aware of local uses and customs, as the region is still dependent on its ancient patriarchal structure. Each village was "quartered" and three members of the team worked in each cardinal point and the center of all villages.

2.3. Data analyses

The independent variables used for the analyses were: age, sex and income and the dependent variables were the answers given by the sample in the questionnaire. Chi-square statistics was used to determine variable relationship. These variables were linked in order to determine the perception and attitudes of the population resident in the area of study.

3. Results and discussion

A total of 26 villages were visited and it was considered that there was a uniformity in the economic status, as the whole region is economically depressed (INEGI, 2004).

The number of villages visited in each municipality was: Pátzcuaro (eight); Quiroga (three); Erongarícuaro (eight) and Tzintzuntzan (seven). Pátzcuaroand Quiroga were not included in the sampling because they are urban areas.The questionnaires covered 3.7% of the households of the region and 33% of the households of the surveyed villages, as a total of 1,243 questionnaires were obtained.

3.1. Socio-demographic profile

Fig. 2 shows the ranges of the ages of the people interviewed, half of them belonging to age groups of up to four decades.

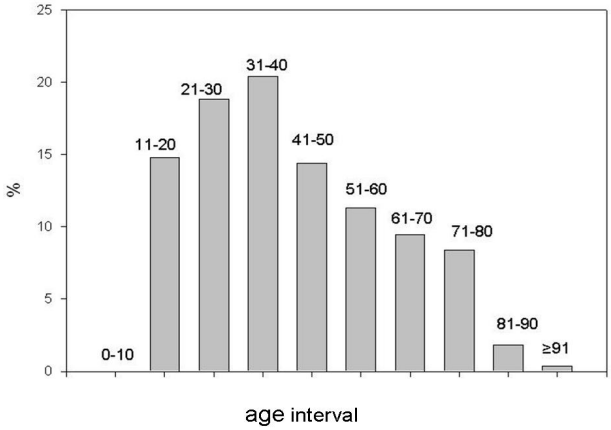

Fig. 2. Age intervals of the interviewed population in the studied area

It was detected that at least half of the households included 4-6 members (Table 2), approximately 90% of the families stated that they owned the house they were living in; even though 84% declared to not to have completed the elementary education, pointing out that they only know how to read and write. The education levelin the areacovers only elementary school (58%) (Table 2). In this region, unless the families are receiving additional income from relatives in the USA, the typical income is only 5-10 USD/day.

It was also detected that 70% of the interviewed population belonged to the female gender. This indicates that the recorded environmental behavior of the studied area discloses mainly the female point of view. This situation resulted as surveys were conducted in the morning time, when men and children had left for work or school; therefore, interviews were answered mostly by women, because the family structure is still traditional in the area: women remain as housewives and men are the main wage earners. Yet, this tendency is changing rapidly across Mexico, 70% of the population now lives in urban areas and females contribute with 29.9% of the gross domestic product (GDP) (INEGI, 2010).

Concerning income and dwelling type, it was revealed that they do not follow a direct proportional relation. That is, even though a low income level was detected in the region, 90% of the interviewed own the house they live in. Even more, during the development of the study, it was also observed that households are made of masonry and have ceramic floors on the inside. Nevertheless, the education level determined by the interview disclosed a basic education level. These findings agree with the population statistics from developing countries, where education level is also related to income and gender (Parker and Pederzini, 2000).

Table 2. Socio-demographic profile in the Pátzcuaro municipality area

Question	***Answer***[a]	***%***
Inhabitants per dwelling	4-6	52
Household property regime	Own	90
Declared to know how to read and write	Yes	84
Education level	Elementary	58
Total income per dwelling	5-10 USD/day[b]	55
Presence of patio/backyard	Yes	88
Domestic animals	Yes	80
Sanitary facilities	Latrine/earth hole	48

[a]*The answer with the greatest %;* [b]*, In year 2011*

3.2. Solid waste management in the area of study

According to the questionnaires, themainway of solid waste disposal is by means ofthe waste collection truck (Table 3); although the frequency of collection is only once a week, as the truck services the area once or twice per week in 90% of the cases. However, 27% do not use the collection truck, which constitutes a serious environmental risk, as the burning of refuse is common in one of four households.

It is important to point out that the majority of the interviewed (57%) declared to ignore the localization of the landfill. The presence of *patios* (or back yards) was ubiquitous, as obtained responses indicated that 88% of dwellings included them. In addition, a similar percentage declared to feed domestic animals with food scrapes, using the patio as storage for either animals or organic compost (responses not included in the Tables).

3.3. Perceptions regarding solid waste

The perception regarding solid waste in a household or in a community was heterogeneous. One in four did not believe solid waste may be causing any problem attheir households (Table 4).

Table 3. Generalities of solid waste management in the Pátzcuaro region

Question		***(%)***
What is your choice for disposing domestic solid waste?		
Burn it		24
Use open dumps		2
Use collection service		73
Other		1
Frequency of disposal		
Daily		5
Every other day		21
Weekly		60
Once or twice per week		14
Do you know where the community waste is disposed?		
Don't know		57
Local dump		40
Down hill		2
Lake		1

Furthermore, when assessing if the community regarded the presence of scattered litter as a problem, one in five answered that there is no problem whatsoever. In addition, 74% of the inhabitants seem to be aware that the problem will have to be solved concurrently, once everybody takes action, even when 8% of the sample believes that nobody is responsible in the matter. Unexpectedly, there is a wide variability in the perception of the problem that solid waste is causing in the area; 24% declared not to perceive a problem and 39% believe that this is a serious matter. It was found that the gender determines the way that the respondent perceives the problem that solid waste originates in the dwellings. Males tend to resent the problem as causing bad odor (36%), whereas females complain mostly (38%) about insects or vermin nuisances (Table 5) (This agree with previously reported by De Feo and De Gisi (2010) and Desa et al. (2011).

3.4. Attitudes related to the problem of solid waste generation

Inhabitants prefer to dispose of domestic waste by means of the public collection service. However, the occurrence of negative behaviors towards the environment was also observed, such as burning and the use of illegal dumps (Table 6).

According to questionnaires, the region is mainly represented as low income, as 87% of the population obtains salaries from 1 to 25 USD/day and 55% obtains wages that amount only 5-10 USD/day.

Table 4. Problems and putative responsibilities on the solid waste problem

Questionnaire	***(%)***
State the problem that domestic waste causes at your house	
Obstructs the way	12
Insects and vermin	36
Bad smell	28
None	24
State the problem that domestic waste causes within the community	
Bad appearance	56
Plagues (insects and vermin)	11
Offensive smell	14
None	19
In your community, how serious do you consider solid waste problem?[a]	
1	24
2	6
3	19
4	39
5	12
Who do you think is responsible for solving the solid waste problem in your community?	
The government	16
Everybody	74
Mine	2
None	8

[a]*1: No problem and 5: Very serious, urgent treatment*

Table 5. Relationship between gender and the perception of the problem that solid waste problem originates at households, (%)

Sex	***In your opinion, what problem does the solid waste generate in your community?***			
	None	***Foul odor***	***Insects and vermin***	***Obstructs the way***
Male	22	36	25	17
Female	22	26	38	14

Table 6. Relationship between gender and choice of waste disposal (%)

Sex	***Burning***	***Collection service***	***Open dumps***
Male	17	79	4
Female	23	75	2

There is a significant relationship between income and the perception of the problem that solid waste produces in the household. Our results suggest that when related to income, the visual aspect of solid waste represents the main complaint (33%) in the group that receives up to 10 USD/day (Table 7).

3.5. Data analysis

Results of the Chi-square statistics gave three dependent variables significantly related to the gender, six variables related to age and two related to the income level. The level of confidence with which results are presented is 90% and their confidence interval equals 3 (Table 8). Although this study did not include an analysis of solid waste generation; in situ appreciations of household waste, consistently evidenced a smaller organic fraction than expected. Even more, solid waste generation studies performed in other Mexican rural areas showed similar tendencies (Buenrostro and Israde, 2003). This suggests that patios in rural areas may be alternative places for disposal of organic wastes generated in the household.

According to some authors, such as Arora-Jonssons (2011) and Guagnano et al., (1995), women are more environmentally oriented than men; in fact, women are often presented as vulnerable or virtuous in relation to the environment. Yet, in this study, our results do not agree with the aforementioned. Obtained answers revealed that, when declaring the problem that domestic solid waste generates or the choice of refuse disposal, genders tend to agree (Table 4 and Table 5). Results indicate that there is a certain level of unawareness of problems derived from solid waste.

Up to a quarter of the respondents stated that solid waste is not causing any problem in houses or among the community, or that the problem is manageable and/or insignificant. Furthermore, Table 2 also revealed that up to a quarter of the population chose to burn domestic waste, presumably because they did not perceive an environmental problem.

However, there is a clear sense of communal responsibility about solid waste management, as up to 75% of the answers suggested that the community believes the problem will be solved in conjunction with the authorities. This is related to the dilemma of

commons (Ostrom, 2000), individually, they believe that they are not contributing to the solid waste problem and, thus, they expect the solution should come from the rest of the community.

Table 7. Minimum salary income related to the statement of the problem that solid waste originates in households (%)

	What problem does the solid waste generate in your household			
Income*	***None***	***Foulodor***	***Vermin and insects***	***Eyesore***
Less than 1	1	1	0	2
1-2	9	9	7	33
3-5	4	4	4	13
6+	3	2	2	6

**In México, a minimum salary/day is equivalent to 5 USD/day, year 2011*

Table 8. Summarization of significantly related results, when comparing independent and dependent variables

Variables	***Chi-square***	***Degrees of freedom***	***P***
Gender versus			
Statement of the problem that solid waste originates at the household	23.7	4	≤0.001
Choice of domestic solid waste disposal	8.5	2	0.014
Statement of the problem that solid waste originates within the community	9.6	4	0.047
Age versus			
Statement of the problem that solid waste originates within the community	33.9	21	0.037
Magnitude attributed to the solid waste problem	73.6	40	≤0.001
Importance reducing solid waste production	52.0	32	0.014
Affirmation/negation of performing any activity to decrease the amount of produced solid waste	82.4	32	≤0.001
Frequency of solid waste disposal	44.7	24	0.006
Declaration of the problem that solid waste originates at the household	77.8	32	≤0.001
Income versus			
Education level (knows at least how to read and write)	41.6	6	≤0.001
Statement of the problem that solid waste originates at the household	23.1	12	0.0027

This was a very important finding because it emphasizedthe need of implementing first, an environmental education program in order to enhance public awareness along with a sense of belonging.It is of paramount importance to build up these attitudes of belonging and co responsibility among inhabitants, along with programs aiming to avoid social exclusion (Grant, 2001; Hasan and Idris, 2014). According to Chadjipantelis (1998); Tressou-Milona (1998); Young (1999), cited in Paraskevopoulos et al., (2003), social inclusion programs need to exert careful attention to political, economical, and social aspects before attempting to put into operation any solid waste management program; since the exclusion phenomenon is multidimensional, not due only to cultural or ethnical variables.

The accurate identification of these variables and their inclusion in solid waste management programs is crucial to promote environmental perception. This ensures the success of the above mentioned programs, reaffirming the importance of an interdisciplinary approach to the analysis of environmental problems, as in this case: solid waste management in rural communities.

4. Conclusions

In the area of study there is a general lack of knowledge about the environmental problem of solid wastes; and the predominance of females answering the questionnaires did not correspond to a fault in the experimental design. Instead, the situation revealedtraditionalfamily structures in this lacustrine region.

The obtained answers disclosed that the region is indeed under particularconditions, i.e.although it is a low income and low education level area the majority of the inhabitants ownstheir own homes. It was revealing to find that the fraction of the population that does not believe that solid waste is causing any problem at the community is similar to the fraction that burns and/or uses open dumps. Sociodemographic variables therefore, determine a specific environmental perception among residents of the study area, as confirmed by the analysis of significantly related variables.

Poverty and education level are two situations that influence the solid waste management and disposal attitudes and the generation rates and composition of wastes.Hence, the relevance of this research is to establish the foundation of environmental education programs. The former will succeed only under the involvement of both community and authorities.

More studies about the perception of inhabitants with respect to the problem of the generation and disposal of solid wastes are needed in the area of study and this knowledge must be included in the design of programs of environmental education that have to be prior to the implementation of a program of solid waste management. The identification of the general perception regarding SW management should be taken in consideration when

attempting to design environmental education programs.

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