

Original Research Paper

Perception Study of Environmental Pollution of a Watercourse in Guadalajara City, Mexico

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Abstract: The results of an environmental perception study about a contaminated watercourse in Guadalajara Jalisco, Mexico are presented. Percept and opinions of residents were collected by direct interview from a random sample of 370 out of 8 900 dwellings and statistical reliability of 95%. Main results highlighted complains about sewage dumping and related displeasing odor (39.3%), as well as the presence of mosquitoes (17.6%) as disease vectors. At most impacted sites (P3, P4, P6, P8) common reported signs and symptoms were irritation to organs of the respiratory system and headache. Thus, finding a very significant association (chi-square test, $P < 0.0000$) among prevailing environmental conditions and reported symptoms at 95% confidence interval. Finally, 90% of interviewee qualified the channel's environmental quality as very bad, since the benefits they can get from a natural stream like landscape beauty, microclimate regulator or water supply, are limited by the unhealthy state of water.

Keywords: Environmental Percept, Health Percept, Water Contamination, Environmental Quality

Introduction

The state of the environment is crucial when studding people's wellness, although there are many factors conditioning relationships between wellness and illness processes. A science that relates societal and environmental factors is Environmental Health. It considers that humans interact with the environment constantly and these interactions affect quality of life, years of healthy life lived and health disparities.

The World Health Organization (WHO) defines environment, as it relates to health, as "all the physical, chemical and biological factors external to a person and all the related behaviours" (WHO, 2016). Thus, Environmental Health consists of preventing or controlling disease, injury and disability related to the interactions between people and their environment (Rojas *et al.*, 2013).

In most parts of the world's urban scenarios, environmental problems are usual and range from poor air quality, water sanitation, solid waste and poverty.

These issues demand concrete measures to lesser the negative effects on quality of life.

A useful tool to assess the condition of the environment and how it relates to health is perception survey, since citizens express their opinions and feelings about the problem they are facing and yield sound information to design programs, or attention proposals to tackle the complication (Ramírez, 2015). Surveys of public opinion are tools that support research projects, although might be subject to error, but are not necessarily related to a poor selection of samples or representativeness (Mañas, 2005). In the design of surveys of public opinion, the researcher must define variables as accurately as possible to avoid bias or misleading information (Mateo, 2000). Such considerations were approached when designing the questionnaire of this project.

Perception surveys and public opinion studies are relatively recent in social research, but they have reached popularity in modern societies. Such tools are increasingly

present in the public agenda, constituting an essential implement to guide the decisions of governmental and non-governmental organizations.

Conducting a perception study allows us to know how people perceive the environment and how the status of it connects their mental state and feelings (Fernández *et al.*, 2016). Vargas and Gallegos (2005) mentions that healthy environments are beneficial to health and welfare. Kartekin, (2013) comments that relationship with nature influences moods such as depression in children and Karatekin and Imat (2014) states that positive results from environmental intervention generate confidence.

According to Luengo (2002); evaluation of surroundings should monitor qualitative variables such as breathable air, the appropriate proportion of green spaces in terms of expansion, availability and management, personal safety and the quality of services. Risk evaluation concerning toxic substances should be appraised for legislative measures of the use of chemicals. In Latin-American countries such approach is far from being put into practice, as it is the case of pesticides and agro-chemicals which are posing important health problems in the population of rural communities which live nearby shores of contaminated bodies of water.

Particularly in Guadalajara city there is a natural course that used to be a generous stream emerging from the upland of the Colomos Forest to down land in the Santiago River. However, intensive urbanization during the last 50 years has been severely affecting its environmental quality as authorities had failed to value the environmental services the natural stream brings to local community (Arellano, 2012; Orozco and García, 2015)

To analyse the percept regarding environmental conditions along the course of the channel, nearby population was questioned about environmental problems in the area, the frequency of signs and symptoms of health and how they relate the presence of this issue to the quality of the environment. The willing of residents to get involved in actions to improve present environmental conditions was addressed as well.

Materials and Methods

From the origin of the natural course in the Colomos Forest to its convergence with the San Juan de Dios River there were established eight sites of measurement (Fig. 1).

The water course covers a length of 8.7 km and runs along the municipalities of Zapopan and Guadalajara in the northern part of the metropolis (METD, 2015). The location of sampling sites is shown in Table 1 in UTM coordinates. The stream

locates in a watershed of 30.89 km² where 31,109 inhabitants are settled in 8,900 homes and get the positive or negative benefits from the surrounding environment (NISG, 2010). The study covered an area of 200 m both sides of the channel and it was defined using the Arc Gis software as it is described by Sánchez *et al.* (2006).

From the 8,900 homes there was calculated a random sample of 370 homes to be directly interviewed. The survey gathered dweller's percept about the presence of environmental problems, the frequency of signs and symptoms of health and how they relate these issues to the quality of surroundings. Besides their willingness to be involved in actions to improve current environmental conditions (Orozco, 2008).

As water pollution at most sampling sites was evident, only one pilot study was conducted to have a quantitative reference such as a Water Quality Index (WQI). The index was computed using mainly physicochemical parameters and just one biological parameter as shown in Table 2.

Resulted WQI was 52 within a range of 0-100. The obtained number proposed that water was not suitable for farming, fishing, agriculture, recreational use or domestic use. WQI groups the most representative polluting parameters (Table 2) in a unified value, thus being an instrument to qualify the environmental state of bodies of water.

Survey information was analysed by the statistical software Stat Graphics Centurion XV. Particularly the Chi-square test was performed to test the null hypothesis "There is not association between the frequency of signs and symptoms and the environmental status at the different sampling sites".

Table 1: Location of sites along the watercourse (UTM coordinates)

Site	longitude West	latitude North
P1	667376.9	2290891.1
P2	670762.9	2291324.9
P3	671402.4	2291523.6
P4	671656.4	2291783.3
P5	672144.6	2291789.8
P6	672445.8	2291645.2
P7	672648.0	2291985.0
P8	673184.4	2292581.0

Table 2: Physicochemical and biological parameters to compute WQI

Parameter	Parameter
Total coliforms	Hydrogen potential (PH)
Color	Dissolved solids
Electric conductivity	Total phosphates (PO ₄ ⁻³)
Nitrate (NO ₃ ⁻)	Turbidity
Nitrites (NO ₂ ⁻)	Ammoniacal nitrogen (NH ₃)

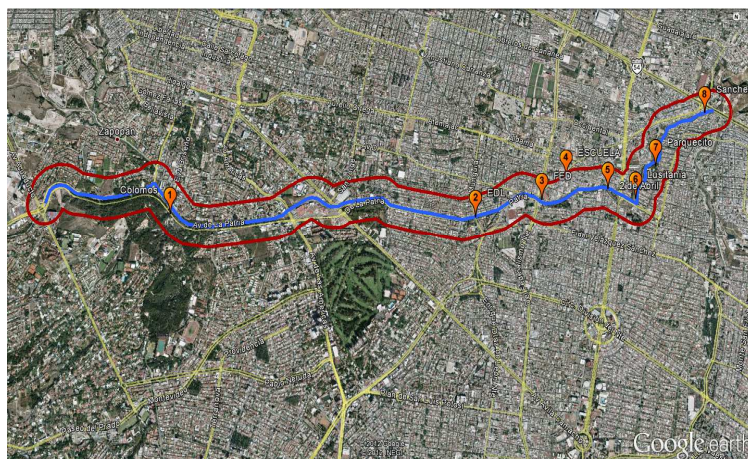


Fig. 1: Location of sampling sites. Blue line corresponds to watercourse and the red one to border line of influence



Fig. 2: Environmental conditions of stream bank from its origin in “Colomos Forest” (a), to its convergence with “San Juan de Dios River” (c) and its final discharge in “Santiago River” (d)

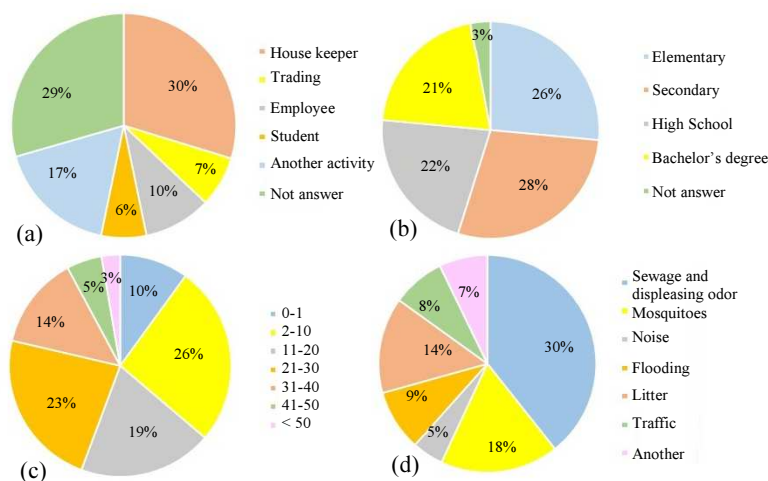


Fig. 3: Occupation (a), Education (b), years of residence (c) and identified environmental problems (d)

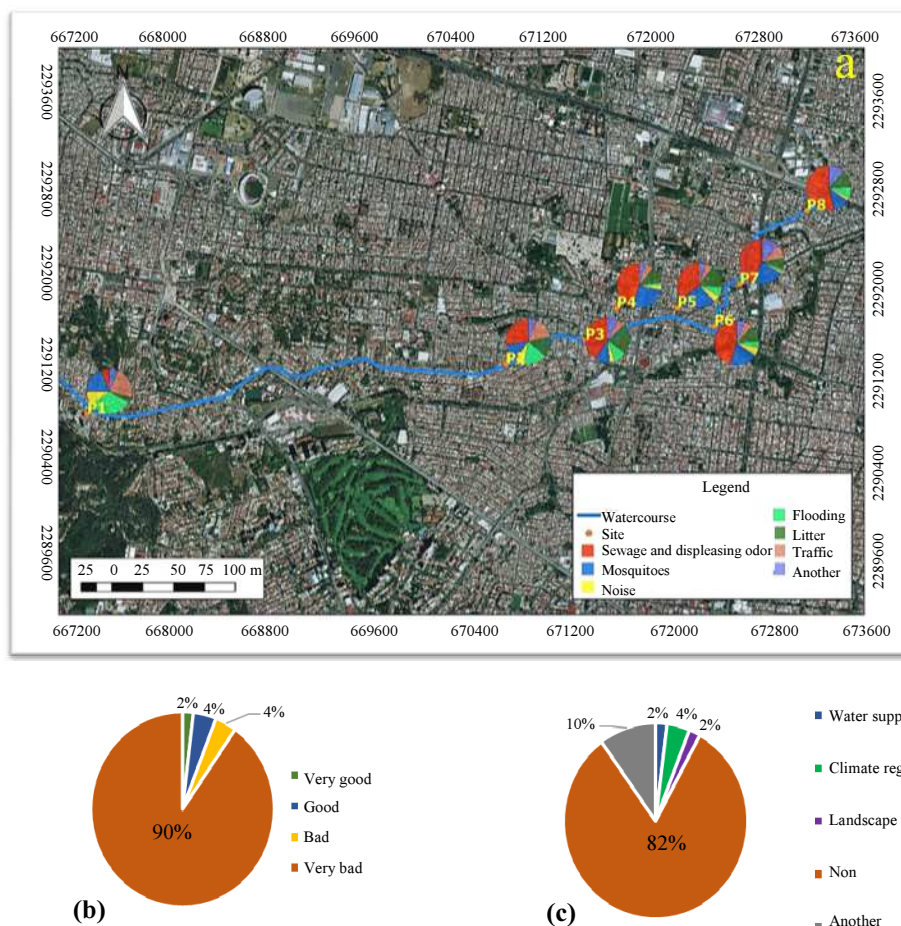


Fig. 4: Assessment of environmental quality (a) Identified problems (b) Perception of environmental quality (c) Benefits from living nearby the watercourse

Results

The results of the study show a gradual deterioration from the origin of the stream in the “Colomos Forest” (Fig. 2a and 2b) to its confluence with the “San Juan de Dios River” (Fig. 2c and 2d). The main problem affecting water quality has to do with sewage, thus altering its physicochemical properties and the generation of displeasing odor. Physicochemical characteristics of water from the pilot study referred a WQI of 52 within a range of 0-100. At this value contaminant in the water are overloaded and the use of the resource for farming, fishing, agriculture, recreational use or domestic use should be avoided. In addition, visual pollution due to solid waste dumping was also a problem.

Survey Results

Results of sociodemographic data from the 370 questionnaires, as well as identified environmental problems by interviewee is presented in Fig. 3. Concerning gender 62.4% of the data corresponded to women and

37.6% to men. About occupation, a proportion of 30% identified themselves as housekeepers, although a similar figure of 29% did not give an answer (Fig. 3a). Schooling showed a homogeneous steady decrease among different educational levels, except for elementary to secondary (Fig. 3b). In relation to the time of residence, most people have been there between 2 and 10 years and secondly from 11 to 21 years (Fig. 3c)

The most common environmental problems reported by responders were sewage and associated displeasing odor (Fig. 3d). Secondly, the presence of mosquitoes, followed by solid waste of domestic origin and in less proportion waste products from commercial activities and services occurring in the area (Fig. 3d). The area of study is part of the number 10 Sanitary Region according to Local Health Authority. Relevant Epidemiology Data for the stream location, refers two main groups of diseases. The first comprises infectious diseases of the digestive system, as it is the case of enterobacteriaceae, amoeba and salmonella. The second, are vector diseases such as classic dengue fever and very few cases of dengue haemorrhagic fever.

Less identified problems corresponded to noise pollution and other events such as smog, animal pests, insecurity and vandalism; in addition to the problems of traffic and flooding (Fig. 3d).

The most polluted sites along the watercourse match waste water discharge from a nearby slaughterhouse, in addition to a local market and automotive services which generate chemicals like mineral oil, solvents and other toxic substances (Fig. 4a: P3, P4, P6 and P8).

The presence of bad smell in the area is frequent during spring when average temperature is warm enough to enhance bacteria growth and consequently displeasing odor due to spoiling of organic matter.

In general terms, the quality of the environment was qualified as very bad by interviewee (Fig. 4b). This is because the benefits they can get from a natural stream like landscape beauty, microclimate regulator or water supply, are limited by the polluted state of water (Fig. 4c). About how the quality of surroundings where they live has an impact on their health and wellbeing, 84.6% of participants were conscious about it.

Signs and symptoms most frequently reported were those related to organs of the respiratory system, such as throat irritation, nasal congestion, coughing and respiratory problems; in addition to headache which

normally follows the saturation of smell sensors because of the persistence of displeasing odor.

To test possible association between occurrence of signs and symptoms and the state of environmental quality at each of the study points, the results of reported frequencies were analyzed through a contingency table by mean of the chi-square test. In this technique the null hypothesis that “there is not association between the presence of signs and symptoms and the environmental conditions at each of the study sites” was tested and produced the results pointed in Table 3.

The chi-square value of 155.86 and $P = 0.0000$, gave relevant information to reject the tested hypothesis with a statistical confidence of 95%. It can be affirmed that prevailing environmental conditions at each point of study are statistically associated with the signs and symptoms of local population.

Column totals (Table 4) show the most commonly reported signs and symptoms.

Larger numbers correspond to affections of organs of the respiratory system (throat irritation, congested nose, coughing, respiratory problems) and headache. Row totals account for accumulated signs and symptoms at each sampling site and higher values in descending order were recorded at P3, P6, P4 and P8 as it is shown in Fig. 4a for the most common environmental problems identified by interviewee.

Table 3: Statistical test of independence

Independence test	Statistical value	Degrees of freedom	P value
Chi-square	155.856	70	0.0000

Table 4: Contingency table showing the association among environmental conditions and the presence of signs and symptoms, (Chi-square 155.86, $P < 0.0000$)

Sites	Signs and Symptoms											Row total
	Headache	Stress	Nausea	Malaise	Diarrhea	Respiratory problems	Congested Nose	Throat irritation	Coughing	Allergy	None	
P1	1	2	1	1	1	18	21	20	16	2	2	85
	0.09%	0.17%	0.09%	0.09%	0.09%	1.53%	1.79%	1.70%	1.36%	0.17%	0.17%	7.23%
P2	15	10	2	4	9	6	14	12	17	6	13	108
	1.28%	0.85%	0.17%	0.34%	0.77%	0.51%	1.19%	1.02%	1.45%	0.51%	1.11%	9.19%
P3	37	22	23	23	34	23	35	35	23	12	4	271
	3.15%	1.87%	1.96%	1.96%	2.89%	1.96%	2.98%	2.98%	1.96%	1.02%	0.34%	23.06%
P4	22	12	9	14	14	21	23	33	31	6	2	187
	1.87%	1.02%	0.77%	1.19%	1.19%	1.79%	1.96%	2.81%	2.64%	0.51%	0.17%	15.91%
P5	8	3	8	1	4	10	13	13	8	9	1	78
	0.68%	0.26%	0.68%	0.09%	0.34%	0.85%	1.11%	1.11%	0.68%	0.77%	0.09%	6.64%
P6	25	13	16	8	9	22	27	31	23	9	9	192
	2.13%	1.11%	1.36%	0.68%	0.77%	1.87%	2.30%	2.64%	1.96%	0.77%	0.77%	16.34%
P7	12	4	4	3	9	8	9	22	16	6	3	96
	1.02%	0.34%	0.34%	0.26%	0.77%	0.68%	0.77%	1.87%	1.36%	0.51%	0.26%	8.17%
P8	27	12	13	9	15	13	18	20	20	9	2	158
	2.30%	1.02%	1.11%	0.77%	1.28%	1.11%	1.53%	1.70%	1.70%	0.77%	0.17%	13.45%
Column Total	147	78	76	63	95	121	160	186	154	59	36	1175
	12.51%	6.64%	6.47%	5.36%	8.09%	10.30%	13.62%	15.83%	13.11%	5.02%	3.06%	100.00

Finally results of the survey concerning the willingness of residents to engage in actions to improve identified impacts were good. Participants demand government to leader a remedial project focused on environmental education, inspection and regulation of sewage discharges and cleaning campaigns. As the most significant measure to finish eminent health hazards for residents, they propose to route the stream through culverts and on top of it built a linear park for leisure. By this action the surrounding can be sanitized both in terms of displeasing odor and landscape improvement.

Findings of this study complement those made by Fernandez *et al.* (2016) in relation to contamination of a well number of natural courses in Latin America, where population growth and the high demand for goods and services, besides lack of environmental management programs that consider the voice of local inhabitants; are the driving forces for the deterioration of these elements of nature.

The approach of environmental problems is complex, but if the feelings and opinions of affected people are heard and consider when designing management programs and policies to tackle the problem, the chance of success will be more significant (Plata and Ibarra, 2016; Vera *et al.*, 2016). Similar arguments are made by Vergel *et al.* (2016) when stating that it is of great importance the involvement of citizens when building the community and not only the aesthetics should be present but relationships among social dimension and nature, life quality, public spaces and security issues must complement it.

Jiménez *et al.* (2015) discusses relevance of subjective evaluations when assessing sanitary risks of a polluted zone through social perception and refers this approach of research as a significant tool to confirm people's feelings and opinions. In this sense it is important to take into consideration that health and environmental quality are close together and if we want to advance in better health it is also essential to consider comprehensive environmental policy to improve environmental quality in critical areas, such as the one identified in this study.

Conclusion

Most relevant problems referred by interviewee were related to the presence of sewage and displeasing ODOR with a 39.3% as well as the presence of mosquitoes 17.6%. Environmental quality was qualified as very bad by 90% of participants. Regarding the perception of noise as a problem, it was blurred due to the importance to other pollutants.

The methodology applied in this project is a basic information tool to enhance responsible action by social, public and private sectors, about the impacts and deleterious consequences of environmental problems on health that occur at critical areas of

environmental interest. Perception studies support intervention actions and facilitate the implementation of sound public policies.

It is necessary to generate a framework solution to promote sanitation of surrounding that improve health of inhabitants, as well as social issues like security, that allows local dwellers of the channel bank to live with dignity and position Guadalajara city on the top rank of urban sustainability. To approach this level Citizens should act in reporting and demanding authorities to solve environmental arising pressures due to the contamination of the channel. Part of this level of consciousness can be reached by environmental education programs by which people can get knowledge of the importance of their participation to improve the environmental status in the area.

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Author's Contributions

Maria Azucena Arellano Avelar: She designed and conducted the study, as well as field work measurements

Martha Georgina Orozco Medina: She supervised the study and offered Advise in the research methodology

Arturo Figueroa Montaña: He performed the statistical analysis and supported field work

Valentina Davydova Belitskaya: She was in charge of graphs and exploratory data analysis

Ethics

The authors declare no conflicts of interest and confirm that the manuscript has been submitted solely to this journal and is not published, in press, or submitted elsewhere.

References

- Arellano, M.A., 2012. Analysis of environmental health conditions in the Chanel of Patria Avenue, 2011-2012. Unpublished dissertation in partial fulfillment of the requirements for the degree of MSc Environmental Health, University of Guadalajara, Jalisco, Mexico.
- Fernández, M., T.F. Solís and G.D.L.S. Beltrán, 2016. People's perception about the state of environmental pollution in Milagro River and their preventive knowledge about its contaminant load. *Science J.*, 9:125-134.
- Jiménez, M., A. Ferrer, L. Chaves, O.E. Navarro and J.G. Marín *et al.*, 2015. Preliminary analysis of a social perception survey concerning atmospheric pollution. *Journal of Public Health*, 17: 713-727. DOI: 10.15446/rsap.v17n5.38474.

- NISG, 2010. Delimitation of metropolitan zones of Mexico, National Institute of Statistics and Geography.
- Karatekin, K. and F. Imat, 2014. Evaluation of the level of the environment knowledge of teacher candidates of social studies (sample turkey). *Procedia-Social Behavioral Sci.*, 116: 4436-4442.
DOI: 10.1016/j.sbspro.2014.01.962
- Kartekin, K., 2013. Perception of environmental problem in elementary student's mind maps. *Procedia-Social Behavioral Sci.*, 93: 868-872.
DOI: 10.1016/j.sbspro.2013.09.295
- Luengo, G., 2002. Urban environmental quality as theoretical and methodological tool: Study of the impact on historic-urbanistic values. *Venezuelan J. Sociology Anthropology*, 33: 126-141.
- Mañas, B., 2005. Statistical background of opinion surveys. *J. Social Sciences Methodology*, 9: 89-113.
- Mateo, M.A., 2000. Problems for comparing surveys of public opinions. *Psicothema*, 2: 373-376.
- METD, 2015. Technical report of the hydrological protected area Colomos Forest-La Campana, Ministry of Environment and Territorial Development.
- Orozco, M.G. and V.J. García, 2015. Strategies for the implementation of a metropolitan program for environmental diagnosis. In: *Environmental studies in urban spaces*, Orozco, M.G. and V.J. García (Eds.), University of Guadalajara pp: 157-163. ISBN 978-607-8336-83-8.
- Orozco, M.G., 2008. Key elements for conducting urban noise studies. In: *Socio-environmental research, paradigms applied in education and environmental health*, Curiel V.A. (Edr), University of Guadalajara, pp: 161-18. ISBN-13: 978-970-2714-13-2.
- Plata, Á.M. and D. Ibarra, 2016. Local perception of the environmental status in the lower basin of the Manzanares River. *Blue Moon J.*
DOI: 10.17151/luaz.2016.42.15
- Ramírez, O., 2015. Identification of environmental problems in Colombia base on social perception of university students at different locations of the country. *Int. J. Environ. Pollution*, 31: 293-310.
- Rojas, R.H., A. Schilman, L.C. López. and J. Finkelman, 2013. Environmental Health in Mexico: Current situation and future perspectives. *Public Health Mexico*, 55: 638-649.
- Sánchez, M.A., A. Roig, M.L. Cayuela and E.I. Stentford, 2006. Bioaerosols emissions from management of organic waste. *Engineering*, 10: 39-47.
- Vargas, M.F. and I. Gallego, 2005. Indoor environmental quality: Wellness, comfort and health. *Spanish J. Public Health*, 79: 243-251.
- Vera, F.F.B., L.G. Luna, C. Delgado and E. Canchingre, 2016. The perception of environmental problems in the city of Esmeraldas. *Knowledge Res.*, 5: 22-34.
- Vergel, M., M.M. Contreras and J.J. Martínez, 2016. Perceptions and features of public space and the urban environment among inhabitants of the city of Cucuta-Colombia. *PROSPECTIVE. J. Social Work Social Intervention*, 21: 213-239.
- WHO, 2016. Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks, Geneva, Switzerland. World Health Organization.