Investigation and analysis of urban noise for sustainability

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5aNS8. Investigation and analysis of urban noise for sustainability

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The concept of urban sustainability involves complex issues such as, civil services, social participation, resilience, productivity, health and development into a multi-level approach of environmental, social and productivity sectors. Viewing environmental noise as part of urban dynamics is essential. However it is almost absent, or underestimated in most of current environmental, social and health policies in the developing world. Efforts to investigate noise pollution towards analysis, regulation, fulfillment, inspection and fines, contribute in a positive way to improve acoustic quality within urban communities. Therefore the ultimate goal to decision makers is to consider noise as a key issue, when establishing or discussing management policies of urban areas, and to transfer the approach to lower levels with preventive and educational measures, rather than restrictive or prohibited, in order to attain sustainability of urban communities.

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INTRODUCTION

For the first time in human history, more than half the world´s population lives in urban areas, due to concentration of activities and opportunities to access a better quality of life. Massive concentrations of people, demand more resources and services disturbing equilibrium of most natural systems sustaining the environment. A significant challenge of urban communities, in addition to resource use and protection of the natural environment is environmental noise.

Noise hazards are one of the most prominent and influential factors affecting the quality of life of city residents and urban environmental quality. The main sources of noise include: transportation infrastructures, specific sources, such as events in open spaces, land uses that attract large crowds of people, centers of industry, employment and commerce, and sources related to high-density areas, as well as sources of noise related to the activities of the municipal authority. In this sense urban soundscapes are significantly different from the rural in terms of quantity and intensity of emission sources, and deterioration of living spaces [1].

In the developed world urban noise is well indentified as an environmental problem, while in most Latin-American countries, and in particular in México it is underestimated or ignored in most official reports, in which figures about water, air pollution and biodiversity loss are mainly stressed [2]. Even there is enough evidence of noise impacts in industrial workers, as hearing impairment and low productivity ratios, the problem has not been given priority in a broadly context, in most of the countries of developing world. Environmental scenarios within these countries lack well-defined inspection and monitoring programs of noise pollution, since authorities focus their attention on more evident and practical environmental issues such as water sanitation, vector diseases and urban wastes. A good example of good noise policies and progress of recognizing urban noise as a polluting agent is Brazil [3].

The definitions of ‘sustainability’ and, even more so, ‘sustainable development’ subsume a number of the following ideas: inter- and intra-generational equity, concern for the future, altruism, the conservation of nature, the protection of natural resources; balanced development. The ideas have been developed from the Brundtland Report, by the World Commission on Environment and Development [4]. In which sustainable development was defined as: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Urban noise links to sustainability in terms of policy frameworks containing explicit noise management guidelines, with the core objective of improving health and wellbeing in urban areas. The presence of environmental hazards within the urban environment encourages generation of information, as well as the establishment of measures to attend the problems and have the opportunity of accessing urban environments on equal terms [5].

Sustainable cities should offer good quality standards to sustain a well-balanced and harmonious life, most of which can be obtained by establishing sound management policies, the presence of green areas, and acoustic barriers alongside roads, as noise abatement strategies to improving environmental quality of inhabitants [6]. Besides changes at institutional frameworks, human values and patterns of social behaviors are also important [7].

Environmental noise alters significantly the quality of living spaces where human communities develop. Therefore it is important to discuss and joint efforts to diagnose, define, evaluate, and monitor urban noise on a well-defined research framework towards sustainability.

This paper defines general concepts of sustainability, and discusses major noise sources in cities, in particular for Guadalajara, México. Finally the paper develops a discussion and proposal considering key issues of noise and sustainability. In broad terms the aim of the study is to analyze and discuss key elements of urban noise, oriented towards sustainable cities as an intervention strategy.

METHODOLOGY

Investigation methods of the study consisted in a revision and analysis of strategic issue applied in environmental plans. Education is one of the most relevant points that promote conscious and voluntary changes based on well-defined environmental education schemes, such as sustainability. Environmental and social psychology approaches are also directed towards transformation of the urban environments, and are recognized as “action models”. They consider participation in the processes of the urban environment. Main steps of the process are previous evaluation of taken decisions, and after evaluation of decided intervention, with the goal of fulfilling population needs [8] [9].

Based on former studies and the research experience on urban noise, the paper presents a three-phase proposal. The first, concerns an analysis of the problem of noise in the cities, and sustainability features of the urban environment. The second performs a discussion and analysis of noise pollution in Guadalajara, México, as a reference of acoustical conditions occurring in large latinamerican cities.
Finally the study suggests an intervention proposal that meets technical, scientific and management elements, with the ultimate goal of enforcing activities to tackle the problem of urban noise.

URBAN NOISE

Noise pollution is recognized as an important environmental factor affecting life quality of city dwellers. It is an unwanted sound from the activities developed in cities. Main sources of noise come from human activities such as: transportation, building and construction industries, industrial complexes, security alarms, and recreational activities. There is agreement among noise policies and health international institutions that excessive noise exposition results in harmful health effects such as, irritability, anxiety, stress, tiredness, as well as physiological effects like sleep disruption, and affections to the central nervous system, metabolism, etc. [10] [11]. All these affects reflect on people´s daily life, thus altering work accomplishment, besides deterioration of recreational and resting spaces. According to the World Health Organization, hearing

loss can occur at lower frequencies as 2000 Hz, and it is not expected to occur at 75 dB(A) or less, even though exposition is long term. If not hearing loss is evident at this level, it does not mean that non-hearing effects are not present [12].

URBAN SUSTAINABILITY

Sustainability concept imply the use of products and services to attend basic needs of present generations, base on conscious use of natural resources, reduction of contaminating emission and wastes, without compromising resources of future generations [13]. Table 1 summarizes common deficiencies in environmental policies.

Table (1). Observed deficiencies in environmental policies (from analyzed studies).

Deficiencies in the execution of environmental policies as a major drawback for sustainable cities
Environmental programs do not consider protection locks against changes of government administrations. There are not any legal or administrative policies that guaranties either maintenance or continuity of successful and functional projects.
A great number of environmental programs do not emerge from the agreement among society, industry, and government. Therefore there are problems for their execution and implementation. In addition programs never reach consolidation and transcend.
Environmental problems are approached by affected scenarios, abiotic medium and biotic medium, instead of boarding the problems as integrated processes. This is why important health hazards like noise are underestimated in environmental management policies.
Cost-benefits effects among preventive and non-intervention measures are hardly quantified. Therefore, sustainability vision for good health quality standards, environmental quality, social and economic development are absent in most of the cases.
Education, prevention and planning are hardly seen as key issues of environmental quality. Much of the effort is put towards legislation, corrective and remediation measures.

A democratic environmental policy should be able to set up limits to handle environmental pressures by means of flexible legislative frameworks. Economic development should not compromise environmental well-being and resources persistence.

Construction of sustainable cities should consider safe inhabitable spaces at which social, cultural, and environmental features are preserved, and human development is allowed, without compromising the environment of future generations [14]. On this basis access to natural resources, education, job, and safe living spaces should be equitable and democratic, and must be a fundamental element of human aspirations.

It is of great value to promote public policies in the development of projects and community programs as a mean of evaluating their importance and efficiency [15]. When in an urban planning process the projects are designed and the programs evaluated, it is possible to avoid past mistakes and re-direct proposals to guarantee success and effectiveness. Unfortunately, pollution prevention programs in México had

failed to account noise pollution as an indicator of urban quality. Urban scenarios that identify noise as an environmental stressing agent, approach the problem as a function of urban infrastructures, like vehicular traffic, width of motor ways, presence of green areas, etc.

Urban sustainability mainly concerns management of hazards, and uncertainties of adaptive capabilities of urban structures. Good examples are: growth ratios, energy fluxes, generation of wastes into which environmental noise emerge as an associated cost of technological progress.

BACKGROUND STUDIES OF URBAN NOISE IN GUADALAJARA, JALISCO, MEXICO

Guadalajara is the second most important city in the Mexican Republic. It occupies an area of 182 Km^2 and geographical locates at 1567 m above sea level. Guadalajara together with the municipalities of Zapopan, Tlaquepaque, Tonalá, El Salto and Tlajomulco conforms the metropolitan zone. Population is 4´262,392 people which correspond to 60% of the state´s total population [16].

The metropolitan zone of Guadalajara initiated in the 90´s rapid growth, thus reaching 440 new inhabitants per day. Population density is about 90 to 100 inhabitants per hectare, although there are significant differences among the metropolitan area. According to the National Institute of Geography and Informatics, the Zaus and Miravalle density reached 400 to 600 inhabitants per hectare [17]. Living complexes have notably increased at the Northwest and South parts, where construction patterns have been modified, and there is tendency to build multi-level complexes. Such changes have prompted traffic congested areas and intensify air and noise pollution problems. Local authorities have the challenge to implement methods, equipment and techniques, as well as increase capabilities of qualified professionals to diagnose environmental problems and perform evaluation studies of contaminants and health.

An important effort on environmental investigations and health has been done by the Institute of the Environment and Human Communities of the University of Guadalajara. For more than 13 years noise pollution studies have been developed, and results of these projects have contributed knowledge about general particularities of urban noise. Particular progress has been made on making proposals to attend noise pollution with the final goal of improving the city´s environmental quality and sustainability. Table 2 shows mean noise levels from above mentioned studies, as a way of comparing scenarios of different acoustic conditions, and highlighting noise pollution as a potential health hazard for exposed population.

Table (2). List of noise studies in the Metropolitan Zone of Guadalajara, Mexico.

Performed noise studies in the Metropolitan Zone of Guadalajara	Mean noise levels dB(A)
Historical city center, 1995	80.5
Guadalajara´s central zone, 1997	74.4
Critical points of vehicular traffic, 2003	79.25
Closed recreational facilities for kids, 2004	89.94
Zapopan historical center, 2004	74.15
Critical points of vehicular traffic, 2005	77.75
Surroundings of primary education centers, 2005	70.3
Preparatory school located at the periphery motor way, 2006	75.9
Psicology Faculty of the University of Guadalajara, 2006	64.5
Critical zone of city center, 2006	83.15
Mean noise levels in personal audio equipments, 2007	80 - 100

Particularities of noise pollution in Latinamerican cities are far from meeting the 70 dB (A) WHO recommended standard. Table 3 presents a comparison of recorded levels from different urban and road noise studies.

Table (3). Comparative data of noise levels and social perception in some latinamerican cities

Recorded Noise Levels	Greater than 70 dB(A)	Reported Noise Annoyances
Perú [18]	100%	62 %
México [19]	86 %	42%
Colombia [20]	85%	64%
Argentina [20]	80 %	55%

Complemented studies of noise pollution projects are questionnaires to know people´s feelings and perception of the problem. A common issue of performed studies is that, people often refer traffic as the main source of noise, and few people recognize noise as a contaminant.

PROPOSAL OF NOISE INTERVENTION

Table 4 presents the proposal of noise intervention, which is built on analyzed documents and methodologies.

Table (4). Noise proposal for sustainable cities

STEPS OF PROPOSSAL	JUSTIFICATION	ACTIONS
ANALYSIS OF DEMAND	It concerns description of the problem. For example analysis of historical records of noise complains, databases of questionnaire surveys about social perception of noise, and background knowledge both at the local and international levels.	To seek and gather information about noise complaints at official institutions, and urban noise investigation at educational institutions. The aim of this step is to develop a database.
CONTEXT ASSESMENT	It is important to consent the initiative by comprehending interests of the different participating authors, i.e. social organizations, private and public sectors, educational institutions, etc. The ultimate goal is to clearly define the initiative to diagnose and characterize environmental noise as a strategy for sustainability in the urban environment.	Arrange meetings with participating authors to agree a common proposal. Define responsibilities, goals and compromises, as well as available resources. Identify funding, technical and human resources for the different phases of proposal. As a final product of actions, an inter-institutional project should be produced, and it must be integrated to institutional development plans as a way of formalizing its incorporation.
INTERVATION ANALYSIS	Define geographic boundaries, physical description of intervention place, usage of available resources in relation to environmental noise, communication networks, etc.	Environmental characterization of sites in terms of: green areas, traffic fluxes, traffic lights, road conditions, height and material of buildings, arrangement of public transport. Noise levels: mean, maximum, minimum. Noise perception surveys.
APPLICATION OF STRATEGY	The strategy joints technical, scientific and management elements, with the purpose of enforcing activities oriented to attend the problem of urban noise. It visualizes improvements in urban infrastructures, adequacy of legal procedures, and urban noise initiatives; as well as changes in the socio-environmental and cultural schemes at institutional and community levels.	Noise measurements demand technical and scientific knowledge to use the right equipment, and to select software packages to validate and analyze data. Management elements develop effective communication channels among participants. The strategy suggests re-arrangement of public transport and heavy traffic routes. Development and access to funding schemes to establish noise monitoring programs and health effect projects. It is suggested to include noise measurement as part of the permanent atmospheric monitoring program, and establish follow up procedures at airports and congested roads as critical points. In a parallel manner, environmental campaigns against noise pollution are implemented from the pre-school to the university levels, covering the aspects of education and culture.
EVALUATION AND MONITORING	After intervention, a cost-benefit evaluation of applied strategy should be practice.	To evaluate the intervention strategy, a physical area is chosen as a pilot project to assess efficiency or re-arrange strategies according to results. Apply methods of economic assessment of environmental projects, and work with social groups in order to get their opinions about result of the applied strategy. If needed some actions are re-arranged.

CONCLUSIONS

Based on presented information it is confirmed that acoustical quality of urban spaces could be used as a good indicator of environmental quality and therefore sustainability.

Environmental noise studies have the ability to be considered as management tools, since they identify and integrate critical conditions within the cities, and point to the presence of contaminant sources.

Noise pollution projects support social denounces and demand authorities to fulfill their obligations, i.e. to make sure that ongoing activity in the cities comply with noise regulations and legal frameworks. They should also promote incentives to encourage improvements within the public transportation and traffic systems, as well as to support inter-institutional projects to monitor and to investigate acoustical conditions of urban environment. In addition planning policies should take into account environmental and health issues, in order to have well-defined environments in terms of the activities these controlled spaces must support, i.e housing, industrial, commercial, and recreational land uses.

Integral studies of noise pollution make possible to identify other environmental threats that harm life quality, and prevent development of sustainable urban communities.

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