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Monitoring and evaluation of air and noise pollution in the city of Sucre

Monitoreo y evaluación de la contaminación atmosférica y acústica en la Ciudad de Sucre

RODRÍGUEZ, Apolonia†, MURILLO, Humberto and DORADO, Luz

Universidad Mayor, Real y Pontificia de San Francisco Xavier de Chuquisaca, Facultad de Ciencias Agrarias, Calle Calvo Nº 132, Sucre, Bolivia.

ID 1st Author: *Apolonia, Rodríguez*

ID 1st Coauthor: *Humberto, Murillo*

ID 2nd Coauthor: *Luz, Dorado*

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Abstract

This project will evaluate the air and noise pollution in the city of Sucre, generated by various sources. Air pollution is an example of a negative externality, in which the actions of an economic agent affect the welfare of other. As well, the use of motor vehicles, whether public or private, affect social welfare by creating damage to human health and the surrounding ecosystem. Therefore, it has paid special attention to the effect of air pollution on the health of the inhabitants of the city of Sucre. Determining the quality and emission levels of combustion gases (CO, CO_2, HC and O_2), particulate matter and noise, and then determine if those levels are within permissible limits set by Norma Bolivian (EQNB 62006, NB 62002, NB-ISO 9096-05) and propose mitigation and control measures based on the results obtained.

Pollution (air and noise), Control and mitigation measures

Resumen

En este proyecto evaluaremos la contaminación atmosférica y acústica en la ciudad de Sucre, generados por diversas fuentes. La contaminación del aire es un ejemplo de una externalidad negativa, en el cual las acciones de un agente económico afectan el bienestar de otro. Como también, el uso de vehículos automotores, ya sea público o privado, afectan el bienestar social al generar daños a la salud humana y el ecosistema circundante. Por ello, se ha puesto especial atención en el efecto de la contaminación atmosférica sobre la salud de los habitantes de la ciudad de Sucre. Determinando cualitativamente y cuantitativamente los niveles de emisión de gases de combustión (CO, CO_2, HC y O_2), partículas en suspensión y ruido, para luego determinar si dichos niveles se encuentran dentro de los límites permisibles establecidos por la Norma Boliviana (EQNB 62006, NB 62002, NB-ISO 9096-05) y proponer medidas de control y mitigación en base a los resultados obtenidos.

Contaminación (atmosférica y acústica), medidas de control y mitigación

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† Researcher contributing first author.

Introduction

Air pollution has been defined by economic theory as a problem of externalities, understood as an effect "where, due to the actual nature of economic and social institutions, costs are imposed on third parties for which no compensation is received, or benefits are granted to others for which no payment is received"1.

Consequences of their behavior, and when in deciding what they are going to produce or consume they ignore the effects of their decisions on third parties. Thus, air pollution is an example of a negative externality, in which the actions of one economic agent affect the welfare of another, who is not compensated for the damage caused. This difference between private benefits and social costs is what justifies government intervention.

Thus, the use of motor vehicles, whether public or private, affects social welfare by causing damage to human health and the surrounding ecosystem. For this reason, special attention has been paid to the effect of atmospheric pollution on the health of the inhabitants of the city of Sucre. Specifically, it has been discovered that the common mechanism by which the damage that air pollution causes to the respiratory and auditory apparatus involves a modification of the immune system's defense processes. The defense processes of the immune system fundamentally9.

The damage to health caused by the substances that motor vehicles release into the atmosphere has different impacts depending on the type, level of concentration and duration of exposure to each of them. Their study has been restricted to the so-called criteria pollutants, such as: carbon monoxide (CO), nitrogen oxides (NOX), sulfur dioxide (SO_2), carbon dioxide (CO_2), oxygen (O_2); and the generation of impact and continuous noise and aerosols.

The only studies that have been conducted on the levels of concentration of pollutants in the city of Sucre due to combustion gases from vehicles was in the year 2000 carried out by Swisscontact with the support of other local institutions, resulting in high percentages of pollution, for example of 2176 vehicles measured that use gasoline as fuel, they failed taking as a reference the regulation of control of air pollution that is stipulated in Law 1333, in 68% compared to 32% of approved of all these vehicles; and by type of service they approved in a percentage of 24.4% of the public service and 32% of the public service. 24.4 % of the public service and failed those of the same type of service in a percentage of 75.5 For the private service, the percentages are 35.6 % passing and 64.4 % failing13. Due to these high rates, it is necessary to perform a new measurement of combustion gases from gasoline vehicles.

Apolonia Rodríguez Gonzales, in 2003 - Monitoring of Atmospheric Pollution caused by the vehicle fleet in the city of Sucre, obtained the following results: Private vehicles are 70% above the maximum levels allowed by Law 1333, public vehicles 85% above the maximum admissible limits and official vehicles 74% above the limits allowed by Law 1333, for the emission of total hydrocarbons into the atmosphere.

Humberto Gonzalo Murillo Avilés, entitled Evaluation of Noise Pollution from mobile sources in district one of the Municipality of Sucre, 2004, obtained the following general results: 78 % of the vehicles exceed the maximum permissible limits according to annex six of the Regulation on Air Pollution and 22 % below those limits15.

Problem statement

The lack of statistical research data on emission levels of pollutants into the atmosphere generated by various sources, to assist in taking preventive and mitigation measures and thus improve the quality of life of the inhabitants of the city of Sucre.

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Objectives

General Objective

Determine the emission levels of combustion gases (CO, CO_2, HC and O_2), suspended particles and noise produced by mobile sources in the city of Sucre, to determine if these levels are within the permissible limits established by the Bolivian Standard and to propose control and mitigation measures.

Specific Objectives

- To determine the levels of atmospheric pollutants: carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbons (HC), oxygen (O_2), suspended particles and noise, through the use of specific measurement equipment, during 2008 and 2009, twice a year (dry season and wet season).

- Identify three representative monitoring points in the city of Sucre for monitoring suspended particulate matter and noise, according to national and international standards.

- Implement a database for the storage of monitoring results.

- Prepare a qualitative and quantitative report of air pollutant emissions generated by various sources.

- Train teachers and university students in the use of equipment for monitoring, subsequent control and evaluation of air pollution levels (combustion gases and particles) and acoustic (noise), in mobile sources, from the air quality control laboratory.

- Evaluate the data obtained through statistical procedures and obtain the inferences or conclusions that lead to new knowledge, and through procedural inductions to achieve the final result, using the monitoring results as a sample.

- Compare the results obtained with those established in the Bolivian Standard EQNB 62006, NB 62002, NB-ISO 9096-05.

- Propose air pollution control and mitigation measures, based on the results obtained.

Hypothesis

The monitoring and evaluation of air and noise pollution from mobile sources will prove that the emission levels of air pollutants in the city of Sucre are above the maximum permissible limits established by Law 1333 (Environmental Law), its related regulations and Bolivian standards EQNB 62006, NB 62002, NB-ISO 9096-05.

Operationalization of Variables

Independent Variables

Monitoring and Evaluation of Air and Noise Pollution.

Dependent Variable

Concentration levels of atmospheric pollutants in the city of Sucre.

Importance and justification

Due to the constant increase of anthropogenic activities, the disorderly growth in the city of Sucre as a consequence of the lack of a Land Use Plan.

In addition to the lack of knowledge of the environmental regulations in force at all levels, it is necessary to carry out a thorough investigation of the concentration level of pollutants emitted into the atmosphere.

In the studies carried out on the impact of pollution on the health of populations in other countries, the long-term generational effects on human beings are not considered. At most, it is stated that -many of the environmental pollutants, especially the physical-chemical ones, have a chronic degenerative effect that translates into an eventual partial or total incapacity‖. This, together with the problems associated with urban poverty, can produce a loss of human capital that is very difficult to recover, i.e., the deterioration of a country's main resource: its population3 .

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Methodology and Materials

Methodology

The following methods were used:

Empirical methods

Experimental, which refers to the different operations and practices to demonstrate, prove or discuss phenomena or their basic principles. The selection of peak traffic hours and the sectors with the highest vehicular traffic will be carried out in order to determine their influence on atmospheric, aerosol and acoustic pollution.

Scientific observation, where the researcher goes to the place where the processes occur for some time and describes how it happens in reality.

Atmospheric, acoustic and aerosol pollution have been measured as they occur in terms of pollution from mobile and fixed sources, seeking a relationship between the levels of pollutants measured and the factors that influence them.

Theoretical methods

- The deductive method will be used to determine the sectors and sampling hours based on the atmospheric, acoustic and aerosol contamination generated throughout the city of Sucre.
- The inductive method.
- Systemic.
- Documental.
- Modeling.

Techniques

Techniques such as data recording and survey have been used:

The Data Recording, noting the different readings of the equipment used for monitoring pollutants such as gas meter, particulate matter and sound meter in stationary and mobile sources, in each of the selected sectors, in the chosen peak traffic hours, the defined vehicle capacity, the selected industries.

The survey uses a ballot to determine the perception of people in relation to the problem of air, aerosol and noise pollution.

Universe

The universe of the present study comprises the - city of Sucre‖ with an approximate population of 270,000 inhabitants. The approximate population of vehicles is 39,524 vehicles (Source: Police, Transit, Vehicle Division, Sucre, 2006), which correspond to the private, public and official sectors, these vehicles are classified according to their capacity as: less than 3000 kilograms and from 3000 to 10000 kilograms and according to the model, according to the regulation of atmospheric contamination of Law 1333 and the industries to be sampled.

Sample

According to the intense vehicular traffic, the activities of the industries and others, the population variance will be estimated with a confidence of 10% of the sample variance of at least 3,900 vehicles. In addition, 3 representative points of the city of Sucre will be taken for monitoring.

Methodology

The following methodology will be used for this study:

In the city of Sucre, the methodology of prediction of atmospheric pollutants will be used, through direct measurement, which will be carried out with the help of equipment designed for this purpose, with which measurements will be taken for a determined period of time, during 2 times per year, to then enter the results in a database and proceed to the tabulation, ordering and evaluation of the results. The following aspects will be considered:

- The evaluation of air, noise and particulate matter pollution will be monitored at 3 representative points in the city of Sucre.
- The measurement time per pollutant, type of source, peak traffic hours, time of year, and others will be determined.

The following diagram will serve as a basis for the evaluation of atmospheric, acoustic and aerosol contamination in the city of Sucre:

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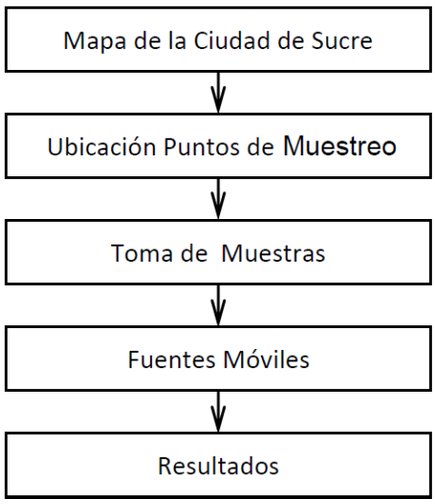

Figure 9 Diagram of atmospheric and noise pollution

Measurement Equipment and Materials

The equipment for monitoring and evaluating air pollution in the city of Sucre is as follows:

- Measurements of combustion gases will be made using special computerized equipment for this purpose.
- Particulate matter will be measured using EVM3 indoor and outdoor particle measuring equipment.
- For noise, a Testo 816 sound level meter will be used.
- The materials to be used for counting stationary and mobile sources are as follows:
- Printed counting record sheets
- Printed sheets for recording pollutant measurement data.
- Pencils and pens
- Stationary material

Direct results

- Noise pollution levels monitored and evaluated.
- Emission levels of air pollutants measured and evaluated.
- Particulate matter concentration levels monitored and evaluated.
- Database of air pollutant emission levels and noise pollution implemented.

Indirect

- Air quality control laboratory with calibrated and functioning equipment.
- Teachers and students trained in the use of equipment.
- Teachers updated and trained in air quality control.
- Owners and population interested in the evaluation of pollution levels caused by emissions from vehicle engines and horns.
- Agreements signed between the Environmental Engineering Department, the GMS Environmental Department, and the Asociación Sucrense de Ecología ASE.

Impact

- Updated data on air pollutant concentration levels in the city of Sucre.
- The Municipal Government of Sucre has updated information that will allow it to implement air pollution control, prevention, and mitigation measures within the current legal framework.
- Sucre Ecology Association with updated information, which will allow the socialization of the same, in various environmental education activities.
- Information generated on concentration levels of atmospheric pollutants, and disseminated through various written and oral media.
- Environmental Engineering career with data from the transportation sector of the city of Sucre on the concentration of carbon dioxide, one of the main contributors to global warming and climate change.

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Communication strategies

Design of the environmental education program, preparation of TV spots, presentation of the results at the VI science and technology fair 2010, preparation of educational booklets, publication in the university magazine Expresión and Correo del Sur.

Conclusions

The percentage of gasoline and compressed natural gas vehicles that pass and fail is 61%, compared to 39% that fail. The percentage of gasoline and compressed natural gas vehicles that passed and failed was 61%, compared to 39% of those that failed, in relation to pollutants such as carbon monoxide and hydrocarbons in 2009. There is a wide margin between those who passed and those who failed. Regarding carbon dioxide (CO_2), the percentage of vehicles using gasoline and compressed natural gas was 58% passing and 42% failing in 2009.

The concentration of suspended solid particles PM10 is higher in the morning than in the afternoon, on Junín street at the corner of Ravelo. The volume of total solid particulate matter (TSP) increases considerably in the morning on Junín Street at the corner of Ravelo Street.

The concentration of suspended solid particles PST and PM-10, are above the maximum permissible limits by Law 1333, both in the morning and afternoon shifts in Junín street at the corner of Ravelo. The concentration of PST exceeds the maximum permissible limits according to Law 1333 on Calvo Street at the corner of Potosí in the morning shift.

The concentration levels of suspended solid particles PM-10 exceed the value recommended by the World Health Organization (WHO), the annual average, at all monitoring points.

The values obtained for suspended solid particles PM 2.5 are below the values recommended by the WHO at all monitoring points.

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