USING GIS TO ASSESS THE SPATIAL DISTRIBUTION OF MEXICO CITY EMISSIONS INVENTORY

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ABSTRACT

The major contribution to the atmospheric contamination is due to the combustion of the oil fuels. The problem consists of locating the emission sources and the type of contaminants produced at the Mexico City. We propose an emissions inventory (EI) instrument to know the emissions by means of a spatial distribution. In the present work, the spatial distribution of the EI 1994 is performed, using a Geographical Information System (GIS). Also, we include the simulation grid for the area and industrial sources at the municipal and sub-municipal levels. The information for the EI has been provided by the National Ecology Institute (INE). The database contains 5019 registers of the several companies. The information consists of the mobile sources, traffic administration data and the total consumption values of gasoline and gas lp (liquefied from petroleum) from PEMEX-GAS project data. For the near 30 000 area sources involving commerce, service of business, population and housing the EI evaluation memoirs for Mexico City and the National Institute for Geography and Informatics (INEGI) data has been considered. The Information processing lead to define the zones of the Mexico City, which present the largest population, the major emission sources, the higher energy consumption, and the bigger contaminants produced in Metropolitan area in 1994.

KEY WORDS

Emissions Inventory, GIS, MCMA, INE, INEGI

1. INTRODUCTION

The relationship between the political, economical, and social processes involved in the Mexico City Metropolitan Area (MCMA) has growth with the time in different human activities in this metropolis. Figure 1 shows the zone to be studied (MCMA), which covers 2,396 km^2. In this area live more than 18 million people, with a fleet close to 3.5 million vehicles, around 35,000 industries and service establishments.

To support these activities, more than 44 million liters of fuel are burned daily. The MCMA is settled in a basin at 2,240 m (7340 ft) ASL, with predominantly East to West wind direction.

Figure 1. Location of study area: Mexico City Metropolitan Area.

As a result from that fuel consumption, a great number of pollutants are emitted to the atmosphere, and the particular topography of the basin. Mountains up to 1500m above ground level in its southern and western borders cause the accumulation of them. The photochemical reactions driven by ultraviolet (UV) radiation from the sun allows to generate the smog.

It is very important to identify where the emission sources are located and how kinds of pollutants are the most emitted in MCMA. A strategic tool to assess that is the EI, published by the National Ecology Institute (INE) and the Environmental Metropolitan Committee (CAM), which is a compilation of the amounts of gases (Carbon monoxide, CO; Sulfur dioxide, SO_2; Nitrogen Oxides, NOx) and pollutants (Total of suspended particles and hydrocarbons) emitted by industries, commerce and service establishments, houses, vehicles, aircraft, soil and vegetation among others.

2. OBJECTIVES

The aim of this work consists of the systematization of the information using EI for every area and point sources. EI allows to the decision-makers and researchers to analyze quantitatively the distribution of pollutant sources, their emissions and its relationship in the MCMA.

3. METHODOLOGY

The available information is used to carry out this work; the PREDATAIND94 database for industry has been developed from a survey conducted by the environmental authorities. In this case, INE and the governments of Distrito Federal and the Mexico State (PROAIRE, 1995). To validate the data, several industries contain bad coordinates or they are located outside of the limits of MCMA. Therefore, they have been excluded. Also these industries did not report the energy consumption and the emissions have been put away.

The computation procedures for the EI of the area sources, ozone precursors and carbon monoxide; population, and housing data; and the total values of the emissions of gas LP have been estimated by PEMEX-GAS and PETROQUÍMICA BÁSICA (1997).

For the data integration, the software ArcView v.3.1 has been used (ESRI, 1998). It had a great utility to analyze and solve problems related to the scale of the spatial problems at MCMA. Using this application, it is easier to make spatial analysis, to obtain the data, to handle the information and to represent it by means of maps. (SENDRA, 1991). This system brings to this work, a powerful tool to handle the spatial data manage for specific areas and point sources, which integrate different databases in a single set of data.

For the database design the entity-relationship model has been used, in which delegations and municipalities form one entity and the attributes of each entity corresponds to the industry and area data. A unique identifier often expressed in a numeric value represents the link between the entity and the data. A specially designed program, SIE-ROX, is used to make the consistency of the data, the joining process is considered by Dbase (DBF) format or texts (TXT). Once the consistency of the data are obtained by the analysis process, which is made into ArcView. The most databases came from economic surveys realized by the INEGI (1999), relating housing, expenditures, services and population by geographic units.

4. RESULTS

4.1. INPUT DATABASE FOR GIS IN POINT SOURCES

Spatial analysis for industry is carried out from 4,135 valid records. The information that has been used for the EI is provided by the INE database, which contains 5019 registered enterprises. Despite this information in some special cases does not present valid records that can be able to define the total emissions in comparison to PROAIRE document, e.g., thermoelectric plants.

4.2. INPUT DATABASE FOR GIS INTO THE POINT SOURCES

Spatial analyses for these sources have been performed at delegation and municipality level. Another database was designed at the scale of simulation grid.

4.3. ADDITIONAL DATABASE

Several files with population and its density and the service establishments in MCMA have been built to gather them in the GIS. The highway and communications layers are used to explain the industry and services locations provided by the Mexican Petroleum Institute (IMP).

The Federal District concentrates the most industries and workers. However, it uses less part of the energy and produces less than the half of total emissions for MCMA. For surrounding municipalities is the most of the emissions and energy consumption. When the total emissions are desegregated, the municipalities contribute with the most of the TSP, SO_2, CO, y NO_x, while only in the Federal District the emissions for HC surpass these in the municipalities.

In general, for NO_x, the energy generation industry counts on the most of the emissions. Printing companies represent the greatest contribution for HC. Carbon monoxide is presented in everybody except for metallurgic industry as well as TSP. The SO_2 gas is concentrated in mineral-metallic industry, meals, wood and timber, vegetables and animals processing and dressing industries.

Figure 2 shows a punctual distribution of the 4135 industries by municipalities and they follow a pattern as given by roads and main avenues. Figure 3 shows the spatial distribution of the total emissions according to the simulation grid has been made. This grid feeds an air quality simulation model and contains its origin at coordinates 2110000 N and 450000 E, Zone 14 UTM system. Each cell has 5 Km of the length.

Figure 2. Spatial distribution of industry in MCMA, 1994.

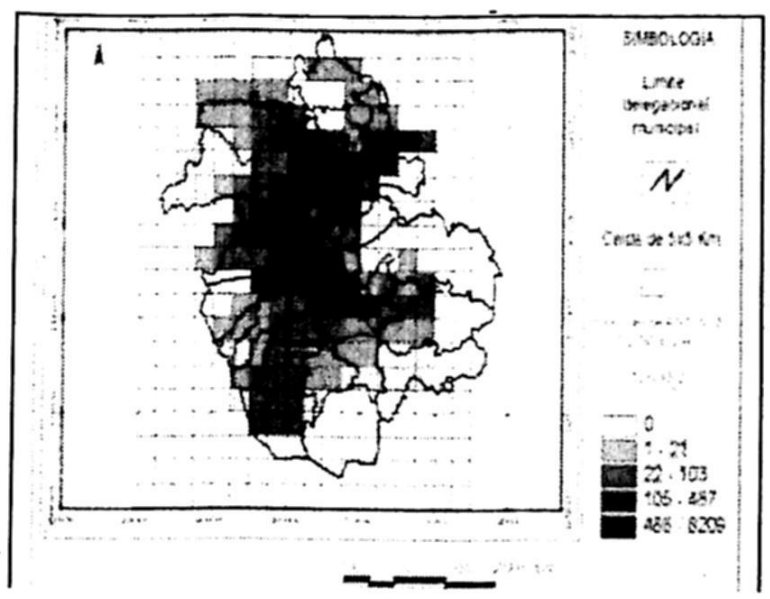

Figure 3. Gridded total emissions of the industry distribution, 1994.

5. CONCLUSIONS

The characterization of a particular region is cartographically represented by common features such as population density, number of sources, energy consumption, and emission generation. They will provide a better planning for measures, which will reduce the emissions, as an emissions inventory makes. The difference is that the map will predict the behavior of pollutants as a variable depending on social, political and economical variables. Thus, the information is useful as input for air quality models.

Using the EI systematization for point sources, the information of 4135 industries have been integrated. These industries count on the 3% of total emissions in 1994. When data have been validated, the found error is 6% with respect to data published by PROAIRE.

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