Phase III Mexico National Emissions Inventory: Point Sources and Future Activities

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ABSTRACT

The Mexico´s National Emissions Inventory (MNEI) was developed in three phases: Phase I, covered a planning and organization program for the development of the Inventory's Preparation Plan; Phase II, included the development of the inventory in the six northern border States of Mexico: Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas; and the Phase III (currently in development), covers the rest of the country, 26 States. The MNEI includes emission estimates for seven pollutants (VOC, CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and NH_3) for point, area, on-road mobile, nonroad, and natural sources.

This paper focuses on the development and conclusion of the Phase III for point sources for the MNEI. The information of point sources emissions was collected, compiled, processed and to some extent estimated by State environmental agencies, the Secretariat of the Environment and Natural Resources of Mexico (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT) and the National Institute of Ecology (Instituto Nacional de Ecología, INE). The point sources were classified according to regulation in federal and State sources. The information of point sources emissions was obtained from both combustion and processing data. Four regional workshops took place throughout the country, with the participation of the State environmental agencies and the Delegations of SEMARNAT, with the objective of developing sufficient capacity to collect, compile, process and estimate emissions for point sources for this phase of the MNEI, as well as quality control and assurance.

Future activities of the MNEI regarding point sources include improvement and data exploitation. Further it is envisaged that institutional capacity will be developed at the State level, in order to create a national system of emissions, a database that would include emissions from criteria pollutants, information from the country's pollutant release and transfer registry (*Registro de Emisiones y Transferencia de Contaminantes, RETC*) and greenhouse gases.

The MNEI represents a significant effort of diverse public and private entities in México, U.S. and Canada. The performance of the first national emissions inventory for México will be finished in April of 2005. The results will be available further in the National Emissions Inventory Format (NIF) for air quality modeling use.

INTRODUCTION

Mexico's National Emissions Inventory project started out in 1995, bringing together Mexico's National Institute of Ecology (INE) and the United States EPA with the support of the Western Governors Association (WGA), with the initial purpose of developing a methodology and an Execution Plan to complete Mexico's National Emissions Inventory. The North American Commission for Environmental Cooperation (NACEC) and the Under Secretariat for Environmental Management and Protection from the Secretariat of Environment and Natural Resources (SEMARNAT) have also become involved in this project as key stakeholders.

Over the past three years the support and collaboration of the aforementioned agencies facilitated the development of the first National Emissions Inventory (NEI) for the country of México. The inventory is seen by Mexican federal environmental authorities as the primary base for initiating air quality management plans and programs in areas not currently covered by the existing air quality management local programs. At the same time, it is also considered as useful input to reformulate or otherwise validate current air quality improvement policies and to develop better regulations. Overall, it represents a unique opportunity to invite all stakeholders with an impact on air quality issues to become involved in this assessment. In particular, for municipal and State authorities participating in the NEI, this effort has provided a unique opportunity for capacity building and technical training.

The inventory comprises point, area, biogenic and mobile sources of 7 pollutants of interest: nitrogen oxides (NO_x), sulphur oxides (SO_x), volatile organic compounds (VOC), carbon monoxide (CO), particulates (PM_{10}, $PM_{2.5}$) and ammonia (NH_3). Emissions data are being collected for 1999, on a State and municipal level, where possible, to allow for future projections up to 2018. The inventory project was planned to be completed in three phases. Phase I included several capacity building activities, the development of the Inventory Preparation Plan and the formation of the Technical Advisory Committee (TAC). Phase II concluded with the completion of the National Fuel Balance and

the emissions inventory for the six Mexican States located on the Mexico-US border (Baja California, Sonora, Chihuahua, Coahuila, Nuevo León and Tamaulipas). The border inventory served as a pilot for what the national inventory would represent in terms of data management from point sources. In this first approach, the environmental authorities from each State coordinated with the designated consultant to hand in, process and validate the point source emissions data to be included in the inventory[1].

Phase III will conclude by mid 2005, when the inventory for the whole country is finished at the municipality level and the methodology for projections is finalized. However, several projects and activities subsequent to the release of the inventory are critical to assure the continuity of the inventory, its future updates and maintenance.

This paper describes the overall process followed for the development of the point source inventory for Phase III. The main information management issues prevalent in Mexico will be discussed, as well as the methodology followed to solve them.

PHASE III POINT SOURCE INVENTORY FOR MEXICO

In Mexico, both federal and State environmental authorities have jurisdiction upon point sources. The Secretariat of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT*) has jurisdiction over point sources belonging to the following industry sectors: chemical, petroleum, petrochemical, paints and dyes, automotive, paper and cellulose, glass, metalworks, electricity generation, asbestos, cement and lime, and hazardous waste treatment[2]. An annual emissions report (*Cédula de Operación Anual, COA*) is compulsory for these point sources and it should be submitted to the Under-Secretariat of Environmental Management of SEMARNAT, either in Mexico City central offices or at SEMARNAT *Delegaciones* located in each of the 31 States plus the Federal District. COAs from federal facilities are included in the national point source emissions database. Several States and metropolitan areas have local air quality management programs, established in coordination with this Under-Secretariat, for which individual COAs are also primary input.

All States including the Federal District have established local environmental protection and management agencies for air pollution prevention and control. State environmental laws are based on the Federal Law of 1996. Also, some of the municipalities, mainly those having large industrial parks or extensive industrial development within their boundaries, have established additional regulations to control air pollution. State, Federal District, and municipal jurisdictions exclude industrial facilities under federal jurisdiction (i.e., those included in the 11 federal industrial sectors and/or located within federal zones). However, they are responsible of the regulation, administration, enforcement, and sanctions for stationary industrial sources within their geographical jurisdictions, including the development of emissions inventories for these sources. For municipalities that have not developed their own air quality programs, the respective State program and regulations apply.

Differences in jurisdiction imply different reporting requirements and formats. For example, point sources under federal jurisdiction are given the option to submit COAs in electronic files or as hard copies, which means *Delegaciones* and the central office sometimes have to capture the data to a database. Reporting requirements and formats for point sources under State or municipal jurisdiction are sometimes similar to federal requirements, but vary between locations, or there may be no requirements at all. This situation imposed a significant challenge, especially given limited human and financial resources and time constraints.

METHODS

To account for emissions from all point sources in Mexico, several concerns had to be addressed. First, the location of 1999 emission data from point sources. COAs from federal facilities were to be found either at SEMARNAT central offices or at State *Delegaciones,* whereas State authorities retrieved and stored their own information. Second, the specific reporting requirements from State environmental authorities. Some local authorities had implemented emission reporting requirements similar to federal COAs, others had different reporting requirements, others had no emission reporting requirements but had information that could lead to estimate emissions – such as fuel consumption, boiler type and capacity, etc. Third, reporting format. Whenever emissions reports were available – such as federal COAs or State reports – they would have to be downloaded to an electronic database. Fourth, data quality. A procedure had to be established to warrant the quality of emissions information was consistent and could be included in the inventory, whatever the source it was taken from.

To retrieve and collect all available emissions data from 1999, involvement of *Delegaciones* and State Environmental Authorities (SEAs) in the project proved was essential. For this purpose, the country was divided into four different regions (figure 1), according to their level of implementation of emission inventory activities. A simplified assessment was carried out by SEMARNAT personnel by contacting each SEA over the phone. Four workshops – one in each region – took place between June and September 2004 where both federal Delegaciones and SEAs were introduced to the project and instructed on information needs and basic QA/QC activities. After each workshop, SEMARNAT staff were in charge of personal follow-up with each State.

Figure 1. Regional groups for the Mexico National Emissions Inventory[3].

To obtain a single database with emission information from all States, all available reports were scanned to retrieve five basic data entries: general information (facility name, location and contact

details), raw materials, main products, information on fuel use and reported emissions. This was useful to identify missing data and to facilitate QA/QC activities later on. If 1999 information was not available or was incomplete, information from years 2000 and 2001 was also considered, if and when operating conditions were approximately constant. Facilities for which information was erroneous or incomplete or could not be obtained from available data were not included in the inventory.

Information gathered from SEAs was merged with the existing information database of federal facilities (DATGEN) located at SEMARNAT, using the five basic data entries mentioned before. Once all facilities were included in DATGEN, they were categorized according to two industrial classifications: the Mexican Classification of Activities and Products (*Clasificación Mexicana de Actividades y Productos, CEMAP*) and the NAICS classification from the US, using the available information on raw materials and main products from each facility. DATGEN was also scanned to detect double counting of facilities or facilities reporting under different company names over the years (in the case of joint ventures, merges and takeovers).

DATGEN emissions data was processed and verified using the following criteria:

- Measurements: Whenever emission concentration measurements were reported (e.g. federal COAs), this information was checked for consistency with reported annual emissions, by performing a back calculation using available information on type of fuel used and operating conditions.

- Reported emissions: If information on measurements was not available (i.e. a significant number of State facilities or incomplete federal COAs), reported emissions were checked for consistency against fuel consumption and equipment capacity, using emission factors.

- Fuel use: If emissions from combustion equipment were not reported or were inconsistent, information on fuel use and AP-42 emission factors[4] were used to estimate them. For facilities using *combustóleo* – the main liquid fuel used in industry in Mexico equivalent to fuel oil no. 6 – AP-42 ratios of PM_{10} (0.76 -0.72) and $PM_{2.5}$ (0.52 – 0.56) were applied. For diesel (equivalent to fuel oil no.2) PM_{10} and $PM_{2.5}$ ratios of 0.5 and 0.12, respectively were applied. These correspond to industrial boilers under poor maintenance conditions with predominantly old burner technologies, an assumption valid for year 1999. In the case of natural gas and LPG, ratios were 1.0 for PM_{10} and $PM_{2.5}$ for external combustion engines. For internal combustion engines, these same ratios applied for natural gas and ratios of 0.97 for PM_{10} and 0.934 for $PM_{2.5}$ were applied for diesel.

- Raw materials and process data: For most point sources, it is not mandatory to report emissions from process operations (i.e. those different to combustion emissions), hence these were estimated using emission factors. For most PM process emissions, CARB $PM_{10}/PM_{2.5}$ ratios were used. On the other hand, when sufficient information on the process was not available, a rule of thumb of PM_{10}= (0.7) PM and $PM_{2.5}$= (0.35) PM was applied. Specific AP-42 emission factors were used to estimate process PM emissions from sugar mills, mines and some foundries. VOCs emissions were estimated by doing a mass balance of solvent use, when sufficient data was available. For gasoline unloading operations in bulk terminals, an emission factor of 0.8 kg/m^3 of VOCs was used for estimations. Additionally, SO_2 process emissions were also estimated through AP-42 emission factors or mass balance calculations in refineries and gas processing facilities. Estimation of SO_2 emissions from cement and lime kilns was

performed considering that 85% of SO_2 is removed by the alkaline raw materials. For PM emissions from combustion in cement kilns, a control efficiency of 90% was assumed.

RESULTS

In the case of State facilities, information on annual emissions was often incomplete, incorrect or inconsistent, due to miscalculations or lack of measurements. Fuel consumption, however, was almost always reported very accurately. As a consequence, it is estimated that approximately 90% of the emissions of the State sources that were included in the inventory were calculated based on this information and applying AP-42 emission factors for fuel oil, natural gas and LPG combustion.

Using other information available to SEMARNAT, industry sectors not currently reporting emissions (i.e. car manufacturing, fuel storage facilities and sugar cane processing facilities) were included in the inventory as point sources. This meant that 75 additional sources were incorporated.

Process emissions of VOCs from the petroleum industry (PEMEX) were included as reported in their emissions inventory, given the quality and completeness of their information. For other federal facilities, data on PM emission concentration, stack diameter, temperature and velocity were used to calculate annual process emissions.

DISCUSSION

This inventory is the first of its kind in Mexico. There is currently no single database with data on emissions from point sources at the municipality level in the country. However, it does present limitations which will serve as basis for improvements and future partnerships and projects in air quality management.

Except for the areas where emission inventories had been compiled before (i.e. the Metropolitan Areas of Mexico City, Guadalajara, Monterrey and Toluca, Tijuana, Mexicali, Salamanca and the State of Hidalgo), detailed information at the facility level was very limited. In general, there was more data available from federal facilities because COA reports are compulsory for these sources. Nonetheless, COAs were often incomplete or incorrect, except for information on fuel consumption. This led to the recalculation of a significant amount of data, through emission factors.

Data limitations were even more evident for State facilities. Four States have no emission reporting requirements and had no information available to obtain estimates. However, the main industrial activities in these States were under federal jurisdiction and emissions from State sources were not expected to be considerable. In this case, emission factors were used to estimate emissions of approximately 90% of State facilities.

It is expected that the extended use of emission factors contributes considerably to the uncertainty of Mexico's point source inventory figures. Moreover, the emission factors used were taken from AP-42, which do not necessarily reflect national conditions and fuel characteristics found in Mexico.

Whichever the limitations of the information generated for this project, much was gained by establishing close contact with SEAs and *Delegaciones* at the four regional workshops. Their understanding of the relevance of compiling this inventory was key in the activities that followed. The

workshops served as basic training for several SEAs, to the point that they performed the first QA/QC controls on their own data. The workshops were also good occasions for SAEs and Delegaciones to convey their concerns and needs to successfully maintain, manage and use air quality information in their own regions. Lack of personnel and adequate training were mentioned as the most common difficulties faced by these agencies. Following completion of the inventory, several activities are programmed to assure continuity of present efforts and to set the stage for future updates.

Future Activities

Several capacity building activities are planned throughout the country, specifically directed at SEAs. Regional training workshops are programmed to share the results from the inventory. These will also serve as opportunities for training State officials in basic emission inventory skills. As a training aid, a workbook will be elaborated which will take into account previous training material. The workbook will include a syllabus on an intensive (20-hour) course on emission inventories, an exercise workbook with case studies and an instructor's manual. This material will eventually be available on a web-based course.

INE has also commissioned the revision and update of the emission inventory manuals available in Spanish via the CICA webpage[4]. The manuals will be grouped together in three books, which will be printed for distribution among SAEs. This will allow officials in charge of emissions inventories to have a ready reference for their work.

A fundamental need in Mexico is a common database for emission inventories. Starting 2004, a project sponsored by the CEC, WGA and INE has the main goal of building a single database with information on emissions of criteria pollutants, greenhouse gases and toxic substances (included in Mexico's RETC). The database (*Sistema Nacional de Datos de Inventarios de Emisiones*, *SNDIEC*) will also contain the main tools and methodologies used for estimations. When the SNDIEC is finalized, environmental agencies throughout the country will be able to calculate, load, retrieve and update emissions information, following strict security protocols. Researchers and the general public will be able to obtain emissions information, but their access will be restricted to preset queries. This system is the first of several steps that will enable continuous improvement of the inventory at the local and national levels.

CONCLUSSIONS

This inventory represents a groundbreaking effort in emission inventory history in Mexico. However, there is considerable ground for improvement to reduce the uncertainty associated with lack of information and the use of emission factors. Measurements are needed to have better estimations and derive national emission factors. Training and capacity building activities, with support of agencies from the US and Canada and the CEC needs to continue in the years to come. As inventory activities increase, staff number and capabilities will need to keep up, otherwise updates will not be feasible. New tools, such as the SNDIEC will allow more efficient communication between stakeholders and will foster improvements in information quality.

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KEYWORDS

Point sources

Mexico National Emission Inventory