15.1 USING GEOGRAPHICAL INFORMATION SYSTEM FOR DISTRIBUTION OF POLLUTANT EMISSIONS WITHIN AN URBAN AIRSHED MODEL GRID SYSTEM

Rajesh Kaushik Mandya, Sunil Kumar and Kuruvilla John *
Texas A&M University-Kingsville, Kingsville, Texas

1. INTRODUCTION

Photochemical modeling studies are undertaken for an area to find out the best means of controlling high ozone levels there. As a part of the photochemical modeling process, the entire area of study needs to be divided into small grids of equal sizes and total emissions of ozone precursors (NOx and VOC) from that area needs to be specified at the center of these grids. Previous studies by Brandmeyer et. al. (2000) and Kim et. al. (2000) have used GIS techniques for emissions allocation into different grids encompassing the study area. Currently a modeling study is being undertaken for the Corpus Christi urban airshed. This paper basically reports on the method, which was used for allocating emissions of ozone precursors from area and non-road sources into grid cells of the two counties of Nueces and San Patricio comprising the urban airshed of Corpus Christi using the geographical information system (GIS) techniques. Two GIS software namely, Arcview and Arcinfo were used in this study for allocation of these emissions and their subsequent visualization (ESRI, 1997a & 1997b).

2. METHODOLOGY

The counties of Nueces and San Patricio are within the Corpus Christi urban airshed modeling domain. This entire modeling domain was divided into 4 x 4 km size grids as required for the photochemical modeling. The co-ordinate system used for developing the grid coverage was Lambert conformal with the central coordinate of the LCP grid located at 100° W and 40° N. A FORTRAN program was used to generate and write the co-ordinates of each grid-cell of the 4 x 4 km grid-system to be generated in a data file. This data file was then input into ArcInfo to generate the grid system. The grid cells of this grid system were generated by using an ArcInfo tool called “generate polygon” provided within ArcInfo. The generated grid system was a coverage feature. It was converted to a shape file by using an other ArcInfo tool called “convert coverage to shape file”. The shapefile was then exported to ArcView for visualizing it in the Lambert Conformal conic projection. The initial and final co-ordinates pertaining to the corners of the grid system covering the Corpus Christi urban airshed was found to be (204, -1368) and (292, -1284), respectively. The number of grid cells needed to cover the Corpus Christi urban airshed was thus found to be 462. After creating a 4-km resolution grid system encompassing the Corpus Christi urban airshed, emissions were allocated to the defined grid system. Primary steps involved in this process were the development of appropriate surrogates for each type of emission and apportioning emissions into the grids using appropriate surrogates. The shapefiles obtained from the census dataset located at www.census.tamu.edu include the following for the two counties:

- County outline theme file
- Street theme file
- Railroad theme file
- Census tract theme file
- Water bodies theme file

The general formula used for apportioning emissions to each grid cell is shown below:
Emission in each grid cell = $\sum\{A/B\}^* (C/D)^*E$,

where,

A = Population of the census tract for population surrogate, or
= Number of houses in census tract for housing surrogate, or
= Length of the rail road in the grid cell for railroad surrogate, or
= Length of the railroad in the grid cell for water body surrogate.

B = Population of the county for population surrogate,
= Number of houses in the county for housing surrogate, or
= Total length of rail road in the county for railroad surrogate, or
= Total length of railroad in the county for water body surrogate.

C = Area of the grid cell census tract for population and housing surrogates.

D = Area of the census tract for population and housing surrogates.

C/D = 1 for railroad and water body surrogates.

E = Emission source for all the surrogates.

3. RESULTS AND DISCUSSION

Figures 1 through 4 are the tile plots showing apportioned emissions of VOC and NOx from various area and non-road sources within the Corpus Christi urban airshed. These plots highlight the spatial density and texture of area and non-road emissions within the urban airshed. It is clear from the figures that NOx and

---

* *Corresponding author address*: Kuruvilla John, Dept. of Environmental Engineering, Texas A&M University-Kingsville, Kingsville, Kingsville, TX 786363;
e-mail: k-john@tamuk.edu

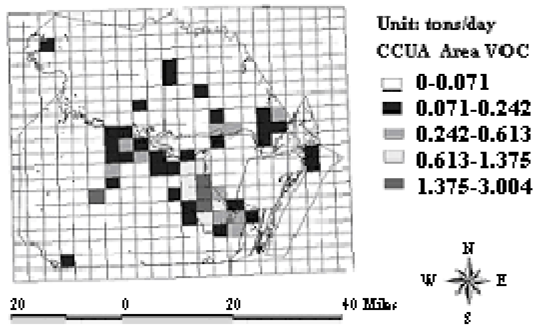

Figure 1: Tile plots for VOC emission from area sources

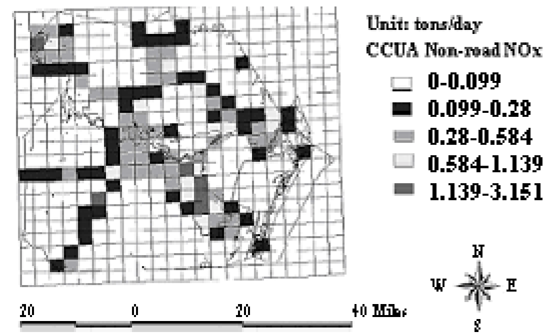

Figure 2: Tile plots for VOC emission from non-road sources

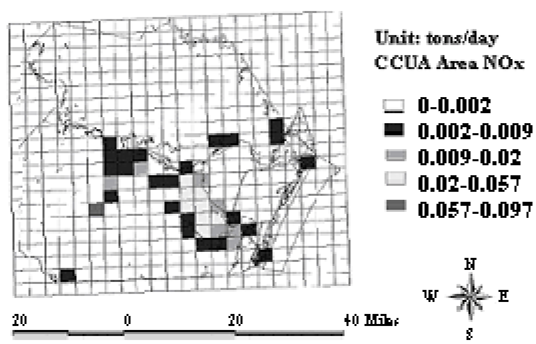

Figure 3: Tile plots for NOx emission from area sources

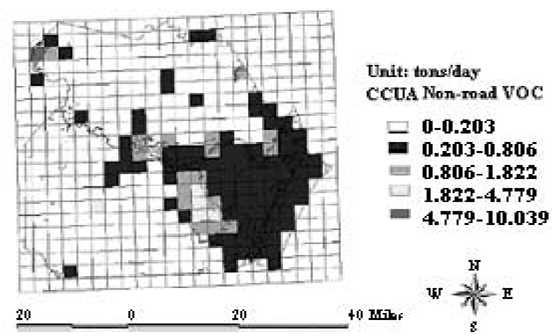

Figure 4: Tile plots for NOx emission from non-road sources

VOC emissions from non-road sources are more widespread than the area sources. Area sources individually seem to be relatively small sources of pollutants, but when combined together become significant.

4. CONCLUSION AND RECOMMENDATIONS

Besides the use of GIS in spatial database development and processing, it can also be used for emissions allocation for modeling purposes. Since GIS facilitates spatial visualization of emissions, allocation of emissions using GIS provides for the adequate quality assurance of the spatial texture of data**.** We have used, wherever possible, better representing surrogates in place of US EPA suggested default ones.

However, there is still a need to choose better surrogates for many of the remaining emissions categories.

Since the activities associated with this are source emissions can be pinpointed to specific points in space, those specific points should be geocoded wherever possible, so that these emissions can be allocated to proper grids and appropriately utilized in the photochemical model calculation.

5. REFERENCES

Brandmeyer, J. E., and Karimi, H. A., 2000: Improved spatial allocation methodology for on-road mobile emissions. J. Air & Waste Manag. Assoc., 50, 972-980.

Kim, D. Y., and Kim J. W., 2000: Development of a speciated, hourly, and gridded air pollutant emission modeling system-A case study on the precursors of photochemical smog in the Seoul metropolitan area, Korea. J. Air & Waste Manag. Assoc., 50, 340-347.

ESRI, 1997a: GIS by ESRI using ArcInfo. ESRI Inc., 380 New York Street, Redlands, CA 92373-8100, USA.

ESRI, 1997b: GIS by ESRI using ArcView. ESRI Inc., 380 New York Street, Redlands, CA 92373-8100, USA.