

6. Biogenic Sources

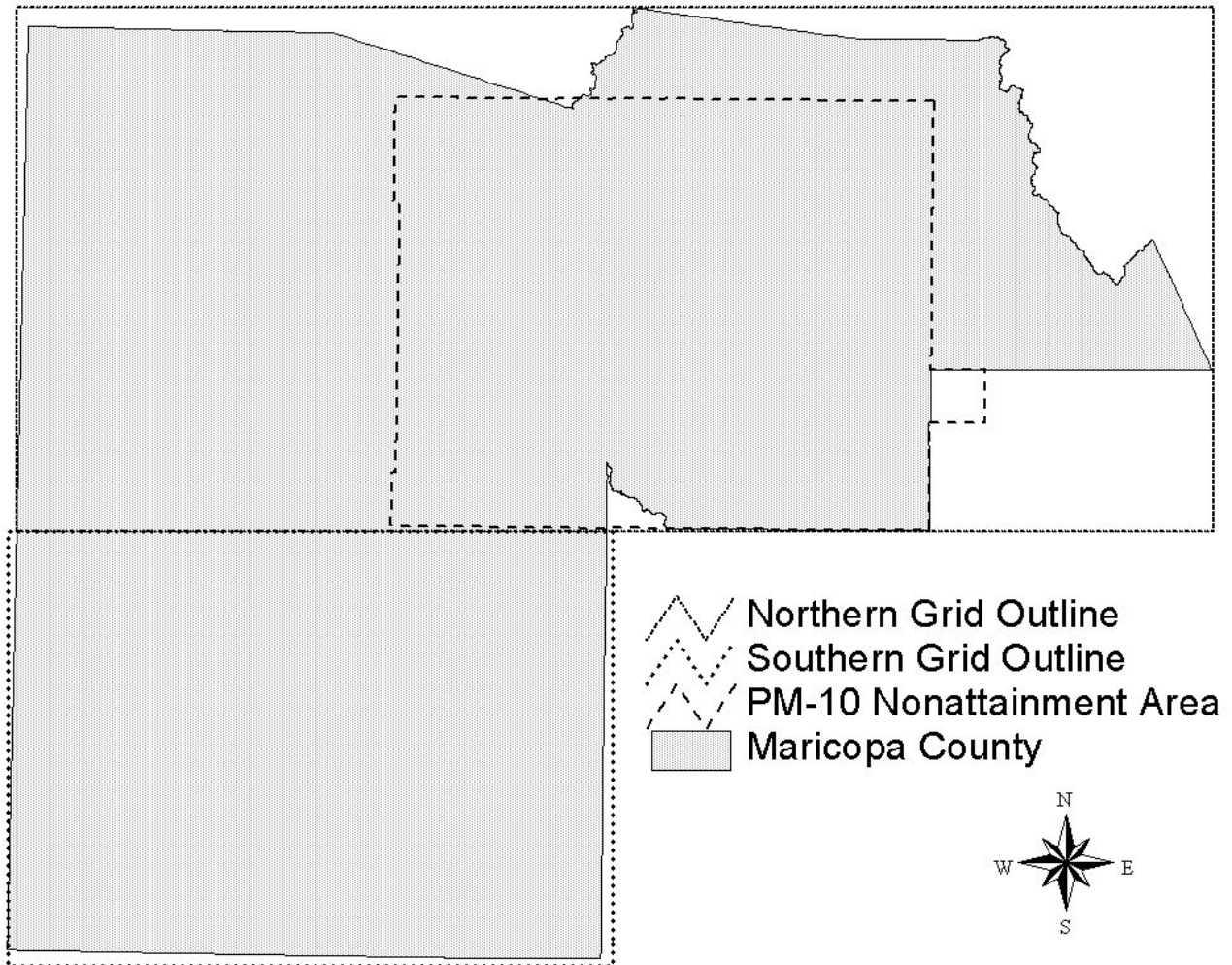
6.1 Introduction and scope

Biogenic source emission estimates have been calculated for PM precursors for use in the 2002 Periodic PM Inventory. These biogenic source emission estimates are for Maricopa County and the approximately 2,900 square-mile portion of the PM₁₀ nonattainment area within Maricopa County and a small portion of Pinal County. These emissions were estimated using a modified version of the UAM-BEIS 2 model called MAGBEIS2. MAGBEIS2 was developed for use in Maricopa County and is documented in Improvements to the Biogenic Emission Estimation Process for Maricopa County, STI, 1996. MAGBEIS2 main modifications to UAM-BEIS2 was the addition of procedures that allow for the input of user-supplied gridded land use and surface temperature data. These procedures included the development of a land-use preprocessor called MAGLAND2 to consolidate the MAG land-use data and to substitute data for missing or incomplete grid cells. The guiding principle used in the development of MAGBEIS2 was the replacement of some EPA defaults with locale-specific data, including: locale-specific land-use data, locale-specific biomass estimates, and the use of a taxonomic approach to develop local-specific emission factors. Overall, MAGBEIS2 constitutes an improvement over the EPA BEIS2 procedures, and is considered to provide reasonable estimates of the biogenic emissions in the study area. Among the chemical species included in MAGBEIS2, only NO_x is attributable to PM formation. Therefore, only NO_x emissions will be reported in this chapter.

6.2 Modeling domain adjustments

The emissions reported in the periodic inventory are for both the PM₁₀ nonattainment area and Maricopa County. Due to the irregular shape of the PM₁₀ nonattainment area and Maricopa County, it was not possible to use the PM₁₀ nonattainment area or county boundary as the modeling domain for the grid based MAGBEIS2 model. Two modeling domains were used to estimate biogenic emissions for the nonattainment area and Maricopa County. The modeling domains used in the present study are shown in Figure 6-1. The northern domain consists of 107 grid cells in the east-west direction and 47 grid cells in the north-south direction, with a uniform grid spacing of two kilometers. The northern domain encompassed the entire PM₁₀ nonattainment area. The southern domain encompassed the southern portion of Maricopa County and consisted of 54 grid cells in the east-west direction and 39 grid cells in the north-south direction, with a uniform grid spacing of two kilometers. Both domains are primarily located within Maricopa County, although small fractions of the modeling domains extend into other neighboring counties. The emissions estimated using the MAGBEIS2 model are for the rectangular modeling domain previously described. These estimates were adjusted to calculate the nonattainment area emissions and Maricopa County emissions through the use of ARCVIEW. ARCVIEW was used to remove the portions of the modeling domain outside of the Maricopa County area for the county emission estimates, and outside of the nonattainment area for the nonattainment area emission estimates.

Figure 6.2–1. PM₁₀ nonattainment area, Maricopa County, and biogenic modeling domains (northern & southern grid outlines).



6.3 Land-use categories

The most critical input for the biogenic emission modeling is the land-use data file. The most recent land-use information was incorporated into the EPA BELD3 land-use data to create a merged land-use data set. The most recent land-use data compiled by MAG included over 40 land-use types using 2000 information as listed in Table 6.3–1. MAG residential, commercial, water, and agricultural land-use categories were merged into the BELD3 USGS coniferous, deciduous, mixed forest, grassland, savanna, and shrubland land-use types, listed in Table 6.3–2, to create a county-wide composite land-use data set. The MAGLAND2 and MAGBEIS2 programs described in the 1996 study by STI and used in previous periodic ozone emission inventories had to be modified to accept the land-use categories from the merged BELD3/MAG 2000 land-use data set. Due to lack of information for the spatial distribution of the agricultural types in the BELD3/MAG 2000 land-use data there is only one category for agriculture. The agricultural emission factor was updated based on 2002 Maricopa County crop statistics.

Only BELD3 data was available for the portion of the PM₁₀ nonattainment area outside of Maricopa County.

Table 6.3–1. MAG 2000 land-use categories.

ID	Type	Assigned to	ID	Type	Assigned to
100	General Residential	Residential	510	Hotel, Motel or Resort	Commercial
110	Rural Residential	USGS Shrubland	520	Educational	Commercial
120	Estate Residential	USGS Shrubland	530	Institutional	Commercial
130	Large Lot Residential	Residential	540	Cemeteries	USGS Grassland
140	Medium Lot Residential	Residential	550	Public Facilities	Commercial
150	Small Lot Residential	Residential	560	Special Events	Commercial
160	Very Small Lot Residential	Residential	570	Other Employment Low	Nonemit
170	Medium Density Residential	Residential	580	Other Employment Medium	Commercial
180	High Density Residential	Residential	590	Other Employment High	Commercial
190	Very High Density Residential	Residential	600	General Transportation	Nonemit
200	General Commercial	Commercial	610	Transportation	Nonemit
210	Specialty Commercial	Commercial	611	Parking Structures	Nonemit
220	Neighborhood Retail Center	Commercial	612	Parking Surfaces	Nonemit
230	Community Commercial	Commercial	620	Airport	Nonemit
240	Regional Retail Center	Commercial	700	Recreation	not merged
250	Super-Regional Commercial	Commercial	710	Active Open Spaces	USGS Grassland
300	General Industrial	Commercial	720	Golf Courses	USGS Grassland
310	Warehouse/Distribution	Commercial	730	Dedicated Open Space	not merged
320	Industrial	Commercial	740	Water	Water
400	Office General	Commercial	750	Agriculture	Agriculture
410	Office Low Rise	Commercial	800	Multiple Use	Commercial
420	Office Mid Rise	Commercial	810	Business Park	Commercial
430	Office High Rise	Commercial	820	Mixed Use	Commercial
500	General Employment	Commercial	830	Planned Developments	Commercial
			900	Vacant	not merged

Table 6.3–2. Land-use categories from BELD3 used in the emission inventory.

<u>BELD3 Land-use category</u>
USGS_Coniferous
USGS_Deciduous
USGS_Mixed Forest
USGS_Grassland
USGS_Savanna
USGS_Shrubland

6.4 Derivation of emission factors

For each of the 11 consolidated land-use groups, MAGBEIS2 requires as input a standardized emission factor for oxides of nitrogen (NO_x). The emission factors selected for use in MAGBEIS2 are listed in Table 6.4–1. The commercial emission factor is identical to the one developed for the 1996 STI study. The “Agricultural” and “Residential” categories were adjusted based on updated data or assumptions described below.

Table 6.4-1. NO_x standardized emission factors, by land-use category.

Land-use category	NO_x emission factor (µg/m²·hr)
Commercial/Industrial	1.8 ^a
Residential/Schools/Churches	17.4 ^b
Agricultural	140.0 ^c
USGS Coniferous	2.0
USGS Deciduous	2.0
USGS Mixed Forest	2.0
USGS Grassland	27.0
Water	0.0 ^d
USGS Savanna	27.0
USGS Shrubland	57.8
Nonemitting	0.0

- a. US EPA emission factor for grass multiplied by the landscape fraction.
b. US EPA emission factor for commercial and industrial multiplied by the landscape fraction.
c. Based on locale-specific data.
d. US EPA-recommended values.

The development of the emission rate estimate for the “Agricultural” category utilized Arizona crop statistics for 2002 obtained for Maricopa County by land-use type as documented in AAAS (2002). These values are shown in Table 6.4-2. The acreage shown in this table were used to derive the percentages of these crop types relative to the total crop land-use area: Cotton - 25.04 percent, Alfalfa - 37.64 percent, Other Hay - 4.09 percent, Wheat - 7.42 percent, Barley - 9.27 percent, Corn - 0.11 percent, Vegetables - 10.91 percent, Citrus - 5.51 percent. These percentages, as fractions, were multiplied by the US EPA-reported standardized emission factors for NO_x for each crop type to get a composite emission factor for harvested cropland areas. The emission factor for “Citrus” is the same as that reported by EPA for orange. Since the 2000 MAG land-use data only contain a single agriculture category, MAG calculated a composite emission factor based on the land distribution fractions for harvested cropland and non-harvested croplands from the latest available Census of Agriculture, 1997.

Table 6.4-2. Maricopa County crop statistics for 2002.

Crop	Acres *	% of total
Cotton	45,900	25.04
Alfalfa	69,000	37.64
Other Hay	7,500	4.09
Wheat	13,600	7.42
Barley	17,000	9.27
Corn	200	0.11
Vegetables	20,000	10.91
Citrus	10,100	5.51
Total	183,300	100

* All values were derived from 2002 Arizona Agricultural Statistics, Arizona Agricultural Statistics Service, 2003.

Table 6.4-3 shows the total areas and percentages for harvested cropland and total cropland . This approach relies on the assumption that the changes occurring in harvested and non-harvested areas has not changed significantly since 1997. As a result, the emission factor for the new “Agricultural” category was computed by calculating a weighted average of the harvested cropland emission factor and the non-harvested (grassland) emission factor for NO_x.

Table 6.4-3. Distribution of harvested cropland and total cropland.

Category	Area* (acres)	Fraction (%)
Total cropland	340,563	100
Harvested cropland	296,150	87
Non-Harvested cropland	44,413	13

* USDA 1997 Census of Agriculture.

Maricopa County lies in the arid Sonoran desert. The residential/schools/churches emission factor used the EPA “desert cities” alternative splits which assumes that 70 percent of the urban land use is barren.

All emission factors for the BELD3 land-use types were taken from the EPA BEIS version 3.09 data set.

6.5 Meteorological inputs

Consistent with previous periodic inventories, for 1990 and onward, the meteorological episode day used was September 9, 1988. The procedures of selecting the episode day was in accordance with the EPA guidance documented in the User’s Guide to the Personal Computer Version of the Biogenic Emissions Inventory System (PC-BEIS), Version 2.0, EPA, 1991. Meteorological data are input to MAGBEIS2 from two separate files. The first file called “SURMET1” was created using observed data from the Sky Harbor Airport. The file includes the following meteorological fields:

- Opaque sky cover
- Total sky cover
- Fraction of sky occupied by the lowest level clouds and height of that cloud level
- Fraction of sky occupied by the second lowest level clouds and height of that cloud level
- Fraction of sky occupied by the third lowest level clouds and height of that cloud level

The above fields are used to determine the solar radiation fluxes in the current version of MAGBEIS2. The following fields in the data file are not used by the program but the format is reserved for the program to read successfully:

- Sea level pressure
- Wind direction
- Wind speed
- Surface temperature
- Dew point
- Station pressure

The second meteorological data file, “TEMPRTR”, consists of 24 hours per day of gridded surface temperature fields created from a UAM preprocessor program. TEMPRTR is in binary format and can be used as an input to UAM. Data used to generate the surface temperature fields were obtained from ten monitoring sites for the episode day. Table 6.5-1 presents more information about the ten monitoring sites for this analysis.

Table 6.5–1. Information for surface temperature monitoring sites.

Site ID	Station Name	Latitude	Longitude	Network*
AGUI	Aquila	33° 56' 48"	113° 11' 20"	AZMET
BCK1	Buckeye	33° 24' 00"	112° 41' 00"	AZMET
COOL	Coolidge	27° 22' 00"	109° 53' 00"	AZMET
DSTR	Desert Ridge	34° 06' 19"	112° 20' 49"	AZMET
ELOY	Eloy	32° 46' 26"	111° 33' 25"	AZMET
HARQ	Harquahala	33° 29' 00"	113° 07' 00"	AZMET
LITC	Litchfield	33° 28' 02"	112° 23' 53"	AZMET
MARI	Maricopa	33° 04' 07"	111° 58' 18"	AZMET
PALO	Paloma	32° 55' 36"	112° 53' 44"	AZMET
ENCA	Phx. Encanto	33° 28' 45"	112° 05' 47"	AZMET
PGRN	Phx. Greenway	33° 37' 17"	112° 06' 30"	AZMET
QUEE	Queen Creek	33° 15' 30"	111° 38' 30"	AZMET
WADD	Waddell	33° 37' 05"	112° 27' 35"	AZMET

*AZMET: The Arizona Meteorological Network, <http://ag.arizona.edu/azmet/>

6.6 Summary of emissions from biogenic sources

Total biogenic emissions for the Maricopa County 2002 periodic PM emission inventory are summarized in Tables 6.6–1 for both the Maricopa County and PM₁₀ nonattainment area.

Table 6.6–1. Summary of biogenic source NO_x emissions (annual and average day).

Geographic area	Annual emissions (metric tons/yr)	Annual emissions (tons/yr)	Season-day emissions (kg/day)	Average daily emissions (lbs/day)
Maricopa County	7,554	8,327	20,696	45,626
PM ₁₀ NAA	2,220	2,447	6,082	13,408

6.7 References

- Arizona Agricultural Statistics Service, 2003. 2002 Arizona Agricultural Statistics. July 2003.
- Maricopa County Environmental Quality & Community Services Agency, 1993. 1990 Base Year Ozone Emission Inventory, final submittal. July 1993.
- Maricopa County Environmental Services Department, 1996. 1993 Periodic Ozone Emission Inventory. November 1996.
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- US Department of Agriculture, 1999. 1997 Census of Agriculture. AC-A-51. Issued March 1999.
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- US EPA, 1997. Urban Airshed Model (UAM) Biogenic Emission Inventory System Version 2 (BEIS-2) User's Guide. final report, EPA contract no. 68-D3-0034. September 30, 1997.