CASE STUDY # 4: NONPOINT SOURCE BURNING

Part 1: Goal

The objective of this case study is to learn the principles of estimating emissions from relevant nonpoint sources. A nonpoint source does not release pollutants into the atmosphere from a single stack where emissions could be easily measured. Nonpoint sources tend to emit pollutants over broad geographic areas such as from multiple homes in a specified community or wild fires that occur across many hundreds or thousands of hectares. Two different nonpoint source combustion categories are considered in this case study, residential heating and cooking, and prescribed burning. The specific skills intended to be developed in this case study include:

- Identification of nonpoint emission sources;
- Compilation of appropriate and representative activity data;
- Identification and use of appropriate emission factors; and
- Implementation of emission estimation procedures.

Part 2: Problem Description

Note to the student: All of the activity data provided in this case study are fictitious and made up for the sole purpose of demonstrating the emissions inventory methodology. However, the emission factors and their references are based on the actual references as provided.

As winter approaches, the members of a community have noted an increase in the number of respiratory illness cases report to the local clinic. Respiratory illnesses are closely associated with exposure to particulate matter (PM), especially fine PM. Members of the community have identified two possible PM sources that could be associated with this increase in respiratory illness, residential heating and cooking and prescribed burning practices. This case study quantifies emission from both of these nonpoint sources, but what other PM sources should be considered in this study?

The village is located in the mountains and is surrounded by an extensive pine forest. The village has a population of 367 people living in 49 homes. Figure 1 is a map of the village, noting the location of each home or shop and the associated property boundaries. The number inside each property boundary is the area of the property in hectares.

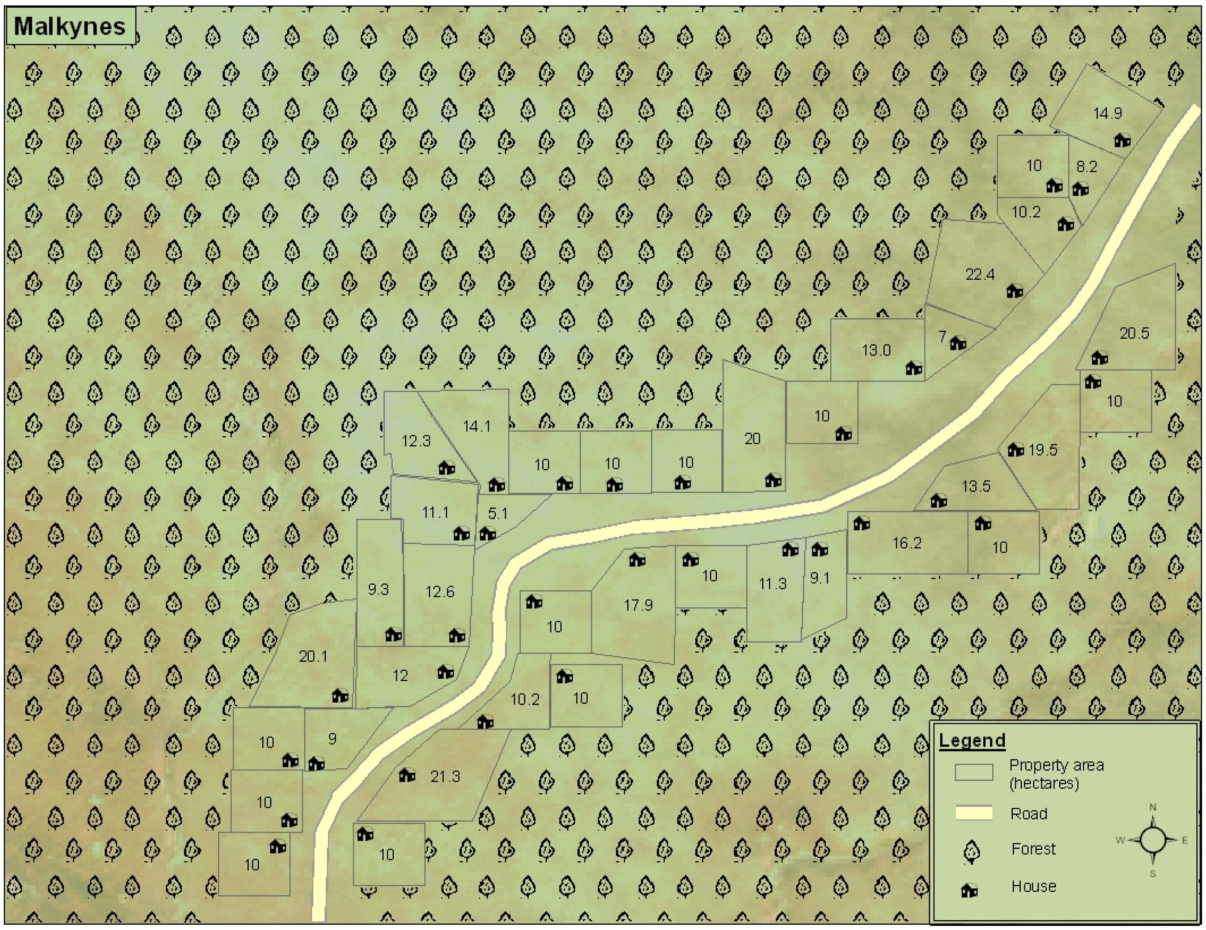

Figure 1. Village - Agricultural Property and Residential locations

Residential Heating and Cooking

Community members burn a variety of softwoods found in the adjacent forests for heating and cooking purposes. A small survey was implemented by community members that provided an average daily residential fuel usage of 10 kg of wood per day per home.

To estimate emissions from residential wood burning the amount of fuel combusted annually by the community needs to be estimated. This can be done by developing typical home fuel usage rates that can be extrapolated to all homes in the community. To estimate the amount of a given pollutant emitted by burning firewood by all homes in the community, the total fuel usage estimate should be applied to appropriate emission factors noted in Table 1. For the purpose of this case study we are only interested in the PM emissions. The same procedures used to calculate PM emissions can be used to calculate emissions for other pollutants if needed.

Table 1. Emission Factors for Residential Wood Combustion

Pollutant	Emission Factor (g/kg of wood)
PM-10	17.3
Carbon Monoxide	126.3
Sulfur Oxides	0.2
Nitrogen Oxides	1.3
Carbon Dioxide	1,700
Total VOCs	114.5
POM	0.0008
Aldehydes	1.2

Prescribed Burning

The village includes land for homes and shops, small vegetable gardens, and areas for cows and goats to graze upon. 95% of the land is used for grazing purposes. All of the grazing land is burned every year in winter to encourage new growth for the animals to feed upon. The grazing lands are mostly grass lands with 10% of the grazing area covered with a few trees and bushes. The grasses are sparse clumps that have been over grazed by local cattle for several years.

To estimate emissions from prescribed burning the mass of material burned needs to be quantified and applied to appropriate emission factors. The mass of material burned is referred to as fuel loading. Some example fuel loading values are provided in Table 2. To use this table, the appropriate fuel default value must be applied to the total number of hectares burned to approximate the total amount of material burned.

Table 2. Sample Default Fuel Loading Data

Fuel Type	Loading Defaults (kg/hectares)	
	Sparse	Abundant
Interior ponderosa pine Litter	567	
Downed woody debris		
0-1 inch diameter	283	
1-3 inches	324	
≥ 3 inches	202	
Duff	5	
Herbaceous ground cover	40	121
Shrubs	0.0	202
Tree regeneration	0.0	121

Table 3 presents emission factors for various pollutants. The emission factors are averages and can vary by as much as 50 percent with fuel and fire conditions. To use these factors, multiply the mass of fuel consumed (i.e., land area x loading factor) by the emission factor for the appropriate fuel type.

Table 3. Emission Factors for Prescribed Burning

Fire Fuel Configuration	Pollutants (g/kg)					
	Particulate			Carbon Monoxide	Volatile Organics	
	PM-2.5	PM-10	Total		Methane	Nonmethane
Hardwood	11	12	18	112	6.1	6.4
Conifer - short needle	12	13	17	175	5.6	3.5
Conifer - Long needle	13	13	20	126	5.7	4.2
Logging slash debris	4	4	6	37	1.8	ND
Juniper Slash	9	10	14	82	6.0	5.2

Table 3. Emission Factors for Prescribed Burning (Continued)

Fire Fuel Configuration	Pollutants (g/kg)					
	Particulate			Carbon Monoxide	Volatile Organics	
	PM-2.5	PM-10	Total		Methane	Nonmethane
Sagebrush	13	15	23	103	6.2	6.9
Chaparral shrub Communities	10	11	20	101	4.5	12.5
Palmetto gallberry	ND	8-22	ND	ND	ND	ND
Grasslands	ND	10	10	75	ND	0

ND - No data

Part 3: Planning

The contents of the Inventory Preparation Plan/Quality Assurance Plan are outlined as follows:

- Background and uses of the inventory
- Inventory scope (i.e., geographic area and population, pollutants of concern, base year, temporal resolution);
- Data quality objectives;
- Inventory resources;
- Emissions estimation methodologies; and
- QA/QC Procedures
  - Internal QA/QC procedures; and
  - External QA/QC procedures (to be conducted in Step 6 by exchanging solutions with another group, and completing the QA/QC Checklist).

Student teams will perform the following activities as part of this exercise.

1. An Inventory Preparation Plan
2. Emissions calculations
3. Documentation outline
4. Student teams will exchange calculations and documentation outline with another team and perform QA on the other team's products.