CHAPTER 1
INTRODUCTION

1.1. Rationale/ Problem Statement

Biomass subjected to open burning includes grassland, agricultural residue, and forest: vegetation that consists of cellulose and hemicellulose, lignin, proteins, amino acids, and other metabolites, including volatile substances. Burning of the biomass has significant impacts on global atmospheric chemistry and global climate change (Andreae and Merlet, 2001).

Biomass burning has been considered as an important source of gaseous and particulate pollutants in the atmosphere (Levine et al., 1991; Andreae and Merlet, 2001; and Li et al., 2007). Global biomass burning was estimated to contribute to about 40% of total increased carbon emission load (Levine, 1991). Gases produced by biomass burning are composed of greenhouse gases (CO_2, CH_4, N_2O); methyl chloride (CH_3Cl), which trap earth-emitted infrared radiation and induce global warming; chemically active gases (nitric oxide, CO, CH_4, and hydrocarbons) that lead to the photochemical production of ozone (or smog) in the troposphere; and other gases that contribute to destruction of ozone in the stratosphere, critical components in shielding the Earth's life from dangerous ultraviolet solar energy (Allen et al., 2004).

Particulate matter (PM) released from biomass burning influences the atmospheric energy budget through direct and indirect radiative effects. Direct effects of the PM on the solar radiation at the Earth's surface include the scattering and absorption of radiation and the subsequent influence on planetary albedo and the climate system. Indirect effects involve increasing cloud condensation nuclei (CCN) and result in the increase in cloud albedo (WMO, 2003, and Cattani et al., 2006). Major component of PM that affects the Earth's radiative balance is the carbonaceous fraction, which includes organic carbon (OC) and elemental carbon (EC). EC absorbs light and some components of OC can be weakly light-absorbing in the visible spectrum, but the major part of OC would mainly influence the direct radiative force through light-scattering process (Watson et al., 2005). However, global cooling and warming effects due to the EC and OC process on radiation budget on the Earth's surface is still unclear.

Another significant effect of particulate matter is the issue of transboundary haze. This problem has been in evidence in ASEAN countries since the large forest fires in Indonesia in 1997; therefore, ASEAN agreement on transboundary haze was declared at the Sixth ASEAN Summit in Viet Nam in December 1998. A framework of the agreement is to monitor transboundary haze and enhance cooperation among ASEAN countries to prevent and control transboundary haze (ASEAN Secretariat, 2003). In Thailand, Thai National Master Plan for Open Burning Control has been developed with responsibility for ASEAN Agreement of Transboundary Haze and to control open burning in a practical way. Types of biomass to be controlled include agricultural residues, municipal solid waste, and forest fires (PCD, 2005).

In Thailand, the major open burning activities are forest fire and agricultural burning. Three major economic crops that residues are usually burned in the field are rice, corn and sugarcane, with harvested area of 11.2 million ha, 0.93 million ha, and 1.05 million ha, respectively, corresponding to about 24% of Thailand, 51 million ha (OAE, 2008).

Gaseous and particulate emissions from biomass open burning are function of burning activity and burning property. Burning activity data are a fraction of crop residue burned in the field, burned area, fire count, and biomass load. Burning property is characterized by combustion behavior and determined by emission factor. Due to the lack of emission factor, most of the emission factor uses reference of Andreae and Merlet (2001) and the Intergovernmental Panel on Climate Change (IPCC). However, emission factors are not the same in the different areas so applying one emission factor to any other place will generate high uncertainty in emission load estimation (Chen, et al., 2007)

Burning activity and property of agricultural residue field combustion data are scarce and subject to high uncertainties since it is quite randomized in time and space. This study aims to estimate carbonaceous particulate matter emission factor from agricultural residue open burning in Thailand, in order to assess emission load of radiative forcing active air pollutants from agricultural open burning and investigate its contribution to regional air pollution and climate change.

1.2 Objectives

1. To develop methodology for measuring emission factor of carbonaceous aerosols emitted from agricultural field burning in Thailand

2. To develop an inventory of carbonaceous aerosol emission from agricultural field burning in Thailand integrating experimental and remote sensing data

1.3 Scope of Research Work

1. Agricultural crop included in this study are paddy, sugarcane and corn
2. Air pollutants considered in this study included key greenhouse gases (CO_2, CO, $PM_{2.5}$) and carbonaceous aerosols (EC and OC)
3. Study area covers Thailand and the year 2007 serves as base year

1.4 Research Framework

The basic equation to estimate the emission load from biomass open burning is

$$E_i = M \times EF_i \qquad \text{Equation 1.1}$$

where E_i is the emission load of pollutant i from the open burning of a given type of biomass, M is the amount of biomass burned (kg) and EF is the emission factor of pollutant i (EF_i) ($g_{\text{pollutant}}/kg_{\text{dry mass of biomass}}$). M is the amount of biomass burned (kg dry matter) obtained by

$$M = A \times BL \times FB \times CE \qquad \text{Equation 1.2}$$

A is area burned (m^2), BL represents biomass load (kg_{dm} biomass/m^2), CE is fraction of biomass load subject to burning, and FB is fraction burned after utilization.

Framework of this study is presented in Figure 1.1.

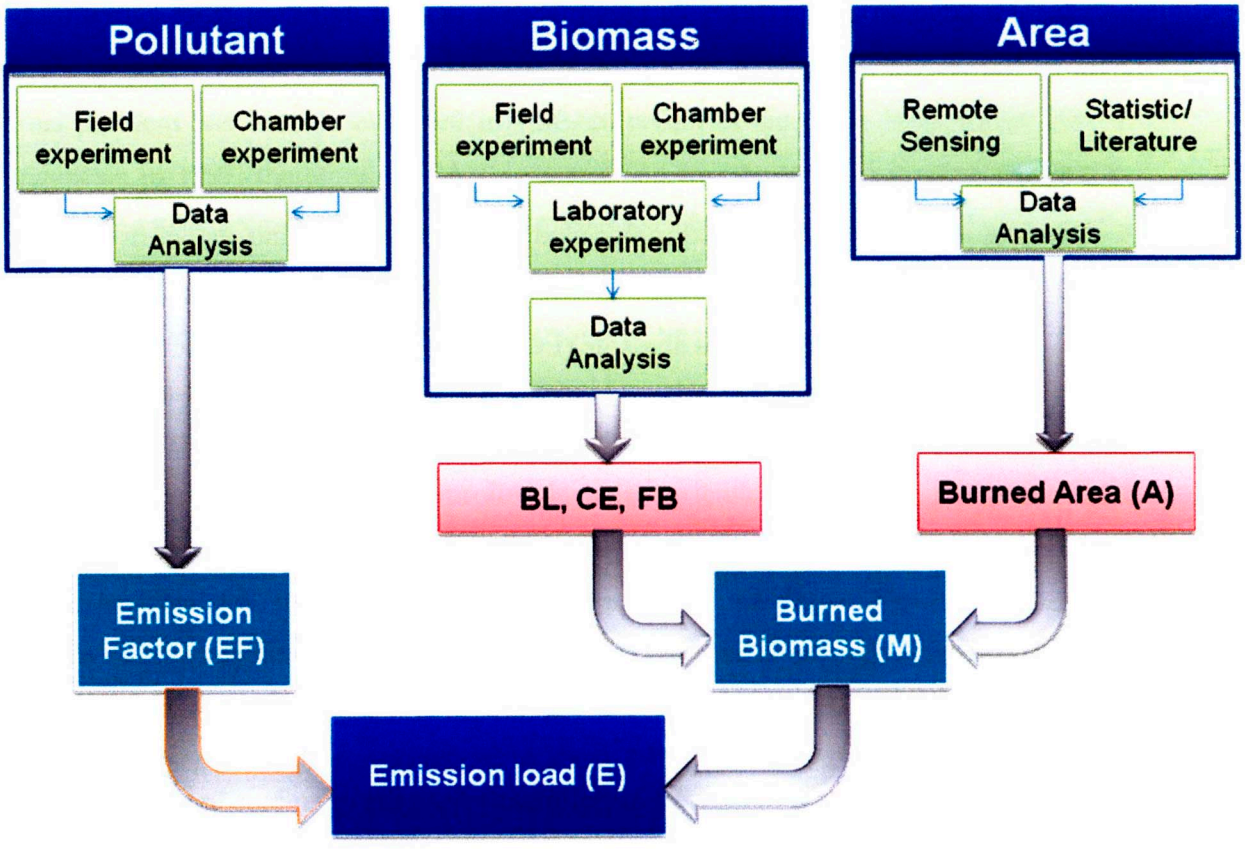

Figure 1.1 Framework of Research.

In order to estimate emission load released from the open field burning of agricultural residues, emission and biomass is quantified by field, chamber, and laboratory experiment; and burned area is estimated by remote sensing and statistical data analysis.

1.5 Expected Results

1. Development of methodology for measurement of field emission factor of carbonaceous aerosols from agricultural burning
2. Field emission factor of particulate matter and carbonaceous aerosols from agricultural burning specific to Thailand
3. Inventory of carbonaceous aerosols and key greenhouse gases emission from major agricultural field burning in Thailand to improve the national and regional emission inventory, and to support the monitoring and modeling of the regional air quality