CHAPTER I
INTRODUCTION

1.1 Rationales and Justification

According to the effect of global warming, human activities are causing an increase in greenhouse gas levels. The burning of fossil fuels and other natural gases, as well as deforestation, is leading to higher concentrations of carbon dioxide. It is estimated the CO_2 concentrations will increase from a current level of 300 ppm to 600 ppm, or maybe 900 ppm, in the next 100 years. It is also estimated that methane could increase from 1,750 ppb at current levels to 3,500 ppb within the year 2100 (UNEP, 2005).

The change in the earth's climate is actually measurable with associated results. Presently, changes in precipitation and rise in sea levels due to climate change, drought, heavy rain storms, flooding, heat waves, decreased agricultural yields, and spreading of diseases are only some of the impacts whose severity would increase as result of climate change and would affect human health, assets, and the social and economic development in every country.

The outcome of the United Nations Conference on Environment and Development (UNCED) is an agreement, known as the Kyoto Protocol, which set the overall goal of reducing greenhouse gases by at least 5 percent below 1990 levels by 2010 -2012 (Luterbacher U. & Sprinz D.F., 2001).

Thailand is listed in the Non-Annex 1 group. This means that it is not obligated to reduce the amount of greenhouse gas emissions. Thailand is only responsible for a small fraction of the total greenhouse gas emissions (about 0.6 percent of the total emissions). In addition, the average per capita emission of Thailand is lower than the average global figures (Climate Change Coordinating Unit**,** 2010).

However, the impacts of overall climate change on Thailand will not be as minimal as its greenhouse gas emission rates. This is because climate change is continually producing impacts, the degree of severity being dependent on the local envi-

ronment and geographical region. Those include sea level, temperature, health and hygiene, biodiversity, drought and flooding.

Beside the destruction of natural resources, Thailand is also facing the environmental pollution problems in the urbanization, due to the rapidly increasing population. As the number of population grows, more resources particularly, food and energy are needed to support their living. Consequently, forest area has to be replaced with agricultural so as to satisfy such that need. The pollution problems in the cities have become even worse when numbers of Thais change from the rural society to the urban, thereby creating a denser population (or polluters) within. As a result, large quantities of wastes (wastewater, solid wastes, and air pollutants) are released to the environment. Without proper management before being discharged, they would, in tum, create the nuisance effects on the communities and/or cause the health problems to population in the affected areas.

Solid waste quantities generated across the country were approximately 14.4 million tons, classifiable as packaging materials, reusable and recyclable products of 6.6 million tons (PCD, 2005). Nevertheless, the effectiveness of solid waste segregation, including the utilizations of packaging waste and reusable materials, have not systematically been studied yet. The key mechanisms having an important role in waste segregation are waste scavenging, and buying back processes. These processes are related to only waste utilization. Waste segregation process mainly depends upon marketing mechanisms and specific demands of vendors. Certain packaging products with are less significance have low market values, causing the disposal of them with municipal solid waste. They finally bring about the consumption of natural resources, energy, and operational budgets.

Solid waste management in Thailand was implemented by the local government organizations including Municipality and Sub-district Administrative Organizations. Most of the Municipalities take care in the urban areas. On the other hand, most of the Sub-district Administrative Organizations do in the larger areas including agricultural areas with low-density people. There were more problems related to solid waste management the Municipalities than in the Sub-district Administrative Organizations. The problems of the Municipality are inefficient collection and disposal of solid waste. The quantity of solid waste components that can be reused such as organic

solid waste and recyclable solid waste, is small compared to the total quantity of the solid waste generated. The reason for this low proportion is the fact that there is no solid waste segregation. Thus, the recycled solid waste was too dirty and unfit for re-use. The quality is very low.

In the 9th Socio-Economic Development Plan (2002-2006) and the National Plan for Solid Waste Management, Thailand recognized the importance of reducing and recycling solid waste and in this regard have promoted people's participation in solid waste management. More than 30% of solid waste is expected to be reused and recycled by 2006. In 2003, only 18% of solid waste was reused and recycled (2.6 Million Tons), which was too low compared to the solid waste that has the potential to be reused (12.7 Million Tons)(PCD, 2004). In this regard, many organizations are promoting and implementing projects/activities to reduce and reuse solid waste. In 2003, the Pollution Control Department implemented the Project entitled "Demonstration of a System for the Separation of Solid Waste and Mechanism for Collecting Back the Used Packages" in Bangkok. In 2004, it also implemented the project that promoted these activities of increasing the efficiency of local government organizations in separating and recycling the solid waste. After the two projects were implemented, the objective of increasing reused solid waste by 20% was achieved. However, there is a need to implement the projects continuously and at the same time increase the number of project sites (DEQP, 2005).

Treatment and disposal of municipal, industrial and other solid waste produce significant amounts of methane (CH_4). In addition to CH_4, solid waste disposal sites also produce biogenic carbon dioxide (CO_2) and non-methane volatile organic compounds as well as smaller amounts of nitrous oxide (N_2O), nitrogen oxides (NO_X) and carbon monoxide (CO). CH_4 produced at solid waste disposal sites contributes approximately 3 to 4 percent to the annual global anthropogenic greenhouse gas emissions (IPCC, 2001). In many industrialized countries, waste management has changed much over the last decade. Waste minimization and recycling/reuse policies have been introduced to reduce the amount of waste generated, and increasingly, alternative waste management practices to solid waste disposal on land have been implemented to reduce the environmental impacts of waste management. Also, landfill gas recovery has become more common as a measure to reduce CH_4 emissions from Solid Waste

Management.

Management of municipal solid waste presents many opportunities for GHG emission reductions. Source reduction and recycling can reduce GHG emissions at the manufacturing stage, increase forest carbon sequestration, and avoid landfill CH_4 emissions. When waste is combusted, energy recovery replaces electricity generated by utilities by burning fossil fuels (thus reducing GHG emissions from the utility sector), and landfill CH_4 emissions are avoided. Landfill CH_4 can be also utilized for its energy potential. When used for its energy potential, landfill CH_4 replaces fossil fuels, as with MSW combustion.

In order to support a broad portfolio of climate change mitigation activities covering a range of GHGs, many different methodologies for estimating emissions will be needed. The primary result of this research is the development of material-specific GHG emission factors that can be used to account for the climate change benefits of waste management practices.

The starting point for the estimation of greenhouse gas emissions from solid waste management is the compilation of activity data on waste generation, composition and management. By using the Carbon Balance Model to investigate the carbon emissions, fixation, or reduction in all activities of Municipal Solid Waste Management will give advantages:

- The resources utilization for municipal solid waste management in Thailand can be estimated based on the carbon balance model.

- The best alternatives of municipal solid waste management in Thailand can be obtained from the model simulation of various extreme scenarios.

The most common disposal system for solid waste management currently in practice in developing countries is the landfills. The impacts of municipal solid wastes (MSW) management on the global warming equivalence of GHGs emissions comes mostly from CH_4 released as biodegradable wastes decay under the anaerobic conditions in landfills. About a third of anthropogenic emissions of CH_4 can be attributed to this source. In contrast to the emission of only 1 % of N_20 and less than 0.5% of CO_2 associated with solid wastes disposal, the reduction of CH_4 emitted from landfills would have the greatest potential for reducing the overall climate change impacts of solid wastes (GTZ, 2003).

Annual estimates for methane emission from landfill and from all anthropogenic sources are 20-70 Tg/yr and 360 Tg/yr respectively (IPCC, 1995). This suggests that landfill accounts for 6-20% of all global methane emission from anthropogenic sources (Thailand Environment Institute, 1997).

In Thailand also, the management of MSW has become a serious environmental concern due to its growing economic development, industrialization, and change in lifestyle and consumption pattern.

Being an efficient, low cost and easily manageable technology, landfills have become the most popular disposal system in Thailand to response towards the Royal Thai Government Policy that every province should have solid waste management plan (TEI, 1997). But the emission of methane is a serious threat which seems to be increased if no measures are applied. Emission of methane from landfill and open dumping was estimated to be 0.121 Tg CH_4/yr in the year 1990 (TEI, 1997). But the Pollution Control Department (PCD) in 2000 had estimated the total methane emission from land disposal in the year 1994 was 19.576 Gg, of which 12.841 Gg (about 66 percent) were from Bangkok and 6.726 Gg (about 34 percent) were from other municipalities. Similarly, the national total emission of CH_4 from all sectors in 1998 was estimated to be 14,152 Gg/yr (MONRE, 2004).

So mitigation of methane and carbon dioxide emission seems to be necessary. The potential approach for this is application of Carbon Balance Model (CBM). The CBM is a method that enables to describe and analyze carbon flow in term of the material balance of a given system. The approaches of CBM that can be applied in solid wastes management sector would be either waste-to-energy such as capturing landfill gas and generate electricity, anaerobic digestion of organic fraction of wastes and production of biofuel, and cogeneration; or reduce the emission by minimizing the wastes volume that would be sent to landfill. The most attractive approaches for this would be the implementation of 3R system, pre-treatment of wastes by applying Mechanical Biological Waste Treatment Process (MBWT), an aerobic system. Though several of these approaches are already in practice Thailand and are contributing to a significant reduction of CH_4, which however have not been designated as CBM projects in the practical stage to date. In fact, CBM is a very new technology and not much work has been done, particularly in solid waste management sector.

To address the waste management needs of such a complicated system in municipalities in Thailand, having densely populated, agro-industrial activities and agricultural activities seems to be an overwhelming task. Problems of data quality and availability cause difficulties for planners and decision makers in comprehending waste production information in order to formulate appropriate management strategies. This study will allow determining the potential and limitations of applying Carbon Balance Model: CBM for environmental planning in this context.

1.2 Research Objectives

1.2.1 To study the unit processes and factors affecting the carbon emission in the activities of municipal solid waste management in Thailand.

1.2.2 To study the potential reduction of carbon emission from municipal solid waste management in Thailand.

1.3 Scope of Study and Conceptual Frameworks

To systematically understand problems related to resource and waste management of the Municipal Solid Wastes Management (MSWM), the method of Carbon Balance Model (CBM) can be applied. CBM is a method that enables to describe and analyze carbon flow in term of the material balance of a given system. CBM studies the fluxes of carbon of resources used and transformed as they flow through a region, through a single process or via a combination of various processes. This allows the identification of weak points, e.g. large waste production in the system and the evaluation of possible solutions. Appropriate management concepts can in the end be adopted by decision makers or planners.

CBM can be contributed to solutions in waste management problem in developing countries especially in urban area or municipalities. It can be applied to investigate the carbon equivalences occurring in the solid waste management practices including: collection, recycling, solid waste disposal on land, biological and other treatments as well as incineration, open burning of waste and reusing solid waste (compost) as fertilizer in agriculture. However, CBM has never been applied in Southeast Asian Countries in the field of environmental sanitation, particularly in Thailand. Therefore, this research aims to apply CBM in environmental sanitation planning in

the selected cities in Thailand. Carbon equivalences occurring in the solid waste management can be categorized into three path ways, emission, fixation and reduction – as depicted in figure 1.1.

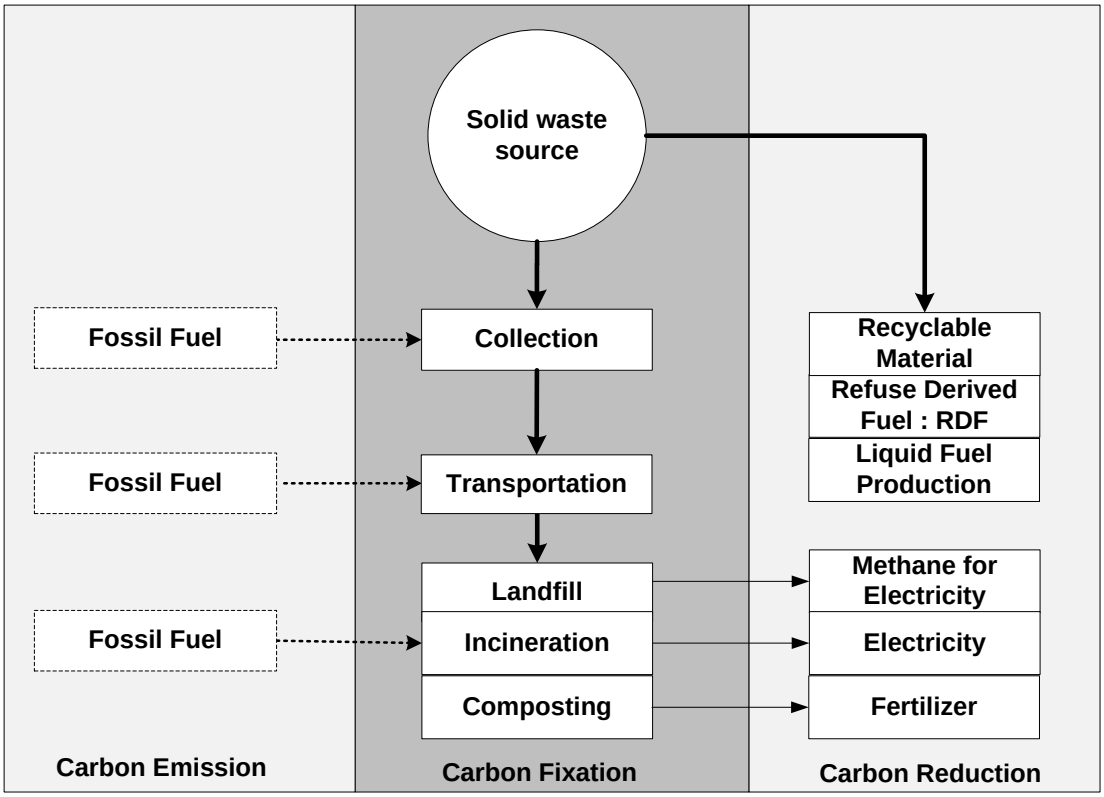

Figure 1.1 The conceptual framework of this research.