CHAPTER I

INTRODUCTION

1.1 Introduction

At the present time, environmental problems are critically important due to the direct harm they impose on human health and life cycles. Hazardous waste contamination is an environmental problem which usually comes from industrial activities such as mining, smelting of ferrous and non-ferrous ore, fertilizer-pesticide application, or improper disposal of municipal waste. These activities result in hazardous waste that is released into the soil, water, and groundwater (Kabata-Pendias, 2001). So, many organizations are searching for methods to prevent and alleviate problems of hazardous waste contamination.

From 1998 to 2003, The International Water Management Institute (IWMI) collaborated with the Department of Agriculture to investigate the amount of Cd contamination at Mae Tao creek, Phra That Pha Daeng sub-district, Mae Sot district in Tak province of Thailand. The researchers found high levels of Cd and Zn in paddy field areas and rice grain. The average levels of both Cd and Zn from the study area and in the rice posed a health risk to the public. Cd was highest along the shore of the Mae Tao River than further in land. From 1998 to 2000, the amount of Cd in the soil ranged from 3.4 to 284 mg/kg of soil, which was between 1.13 to 94 times higher than allowed under the European Community's regulation (3 mg/kg of soil). The range of Cd that was found in rice grain was 0.1 to 0.4 mg/kg of rice grain. The results were also over the standard for Cd in rice grain for 0.2 mg/kg (Codex, 2005). This area was declared a hazardous waste site as it could contaminate the surrounding environment (Department of Primary Industries and Mines, 2004). A remediation of the heavy metals in the soil was researched to reduce or eliminate any risks to humans and the environment.

Remediation technology has many techniques to clean up heavy metal contamination in soil: there are biological treatments using microorganism as well as chemical and physical treatments using chemical oxidation, soil flushing, soil vapor

extraction and solidification/stabilization (Prasad, 2004; Zheljazkov et al., 2006; Hou et al., 2007). However, most of these treatments are rather costly and complex (Ensley, 2000). Thus, the removal of heavy metals by plants has been recommended due to its relatively low cost and high efficiency in the uptake of heavy metals from soil and water. This method is called *phytoremediation*; it uses plants to reduce, remove, degrade, or immobilize contaminant toxins from soil, sediment, sludge, and groundwater (Peer et al., 2007). The plant can dispose of various contaminants; for example, heavy metals, inorganic waste, pesticides, solutions, explosives, petroleum oils, hydrocarbon compounds, polycyclic aromatic hydrocarbon compounds, and wastewater from garbage heap (USEPA, 2000). This technology is interesting and appropriate to the economic situation of Thailand. Phytoremediation is environmentally friendly technology. The use of plants is a natural process and prevents the use of additional chemical substances. Plants can uptake the metals from contaminated soil and translocate them to their roots, stems and leaves. The pollutants are then removed by harvesting the aboveground tissue of the plants which are then incinerated and/or buried (Lai et al., 2004). Some metals can be reclaimed from the ash which further reduces hazardous waste and generates recycling revenues. Phytoremediation technology has been receiving attention lately as an innovative and cost effective alternative to the more established treatment methods used at hazardous waste sites (USEPA, 2000; Sampanpanish, 2005).

Phytoremediation is a biological methodology, which uses selective plants for treating heavy metals. In this research, *Chromolaena odorata* (siam weed) and *Vetiveria zizanioides* (vetiver grass) were selected to reduce the dispersion of heavy metals in soil, due to their physical properties. Not only is *C. odorata* generally found in the local area, but it also grows well in areas with and without contaminated soil. The root of *V. zizanioides* can deeply plunge into soil. So, the plant can translocate large amounts of organic matter and heavy metals. These plant species were chosen for their ability to accumulate total heavy metals, wide distribution, fast growth, hardiness, and easy maintenance. Also, very importantly, they are non-edible and moreover, they have a short life span, high rate of propagation, a large biomass and tolerate multiple heavy metal contaminates in soil (Xia, 2004; Sampanpanish, 2005; Tanhan et al., 2007).

1.2 Objectives

1.2.1 To investigate the removal capacities of selected heavy metals from contaminated soil by *C. odorata* and *V. zizanioides*.

1.2.2 To determine suitability of plant selected to remediate heavy metals accumulation in soil.

1.3 Hypothesis

1.3.1 Heavy metal accumulation in the plants could be increase up to harvesting time.

1.3.2 A high concentration of heavy metals in soil should produce high accumulation of heavy metal in plants.

1.4 Scope of the study

1.4.1 Soil samples in this study were excavated from two areas (uncontaminated soil and contaminated soil) at Mae Sot district, Tak province.

1) Uncontaminated soil containing less than 3 mg Cd/kg was excavated from Mae Ku sub-district. It was used for the control and the synthetic soil.

2) Contaminated soil was excavated from Phra That Pha Daeng sub-district, and contained approximately 40 mg Cd/kg.

1.4.2 The mixture solutions used in this study were:

1) Cadmium (Cd) in the form of cadmium nitrate ($Cd(NO_3)_2.4H_2O$).

2) Zinc (Zn) in the form of zinc sulphate ($ZnSO_4.7H_2O$).

3) Lead (Pb) in the form of lead (II) nitrate ($Pb(NO_3)_2$).

4) Copper (Cu) in the form of copper (II) sulphate ($CuSO_4.5H_2O$).

1.4.3 The plants used in this study are:

1) *C. odorata* seedling collected from Chachoengsao province.

2) *V. zizanioides* seedling obtained from the nursery of the Land Department Development of Pathumthani province.

1.4.4 The time period for harvesting the plants: 30, 60, 90 and 120 days.

1.4.5 Total accumulation of Cd, Zn, Pb and Cu was analyzed in three parts of the plants; roots, stems and leaves.

The scope of this research is shown in Figure 1.1

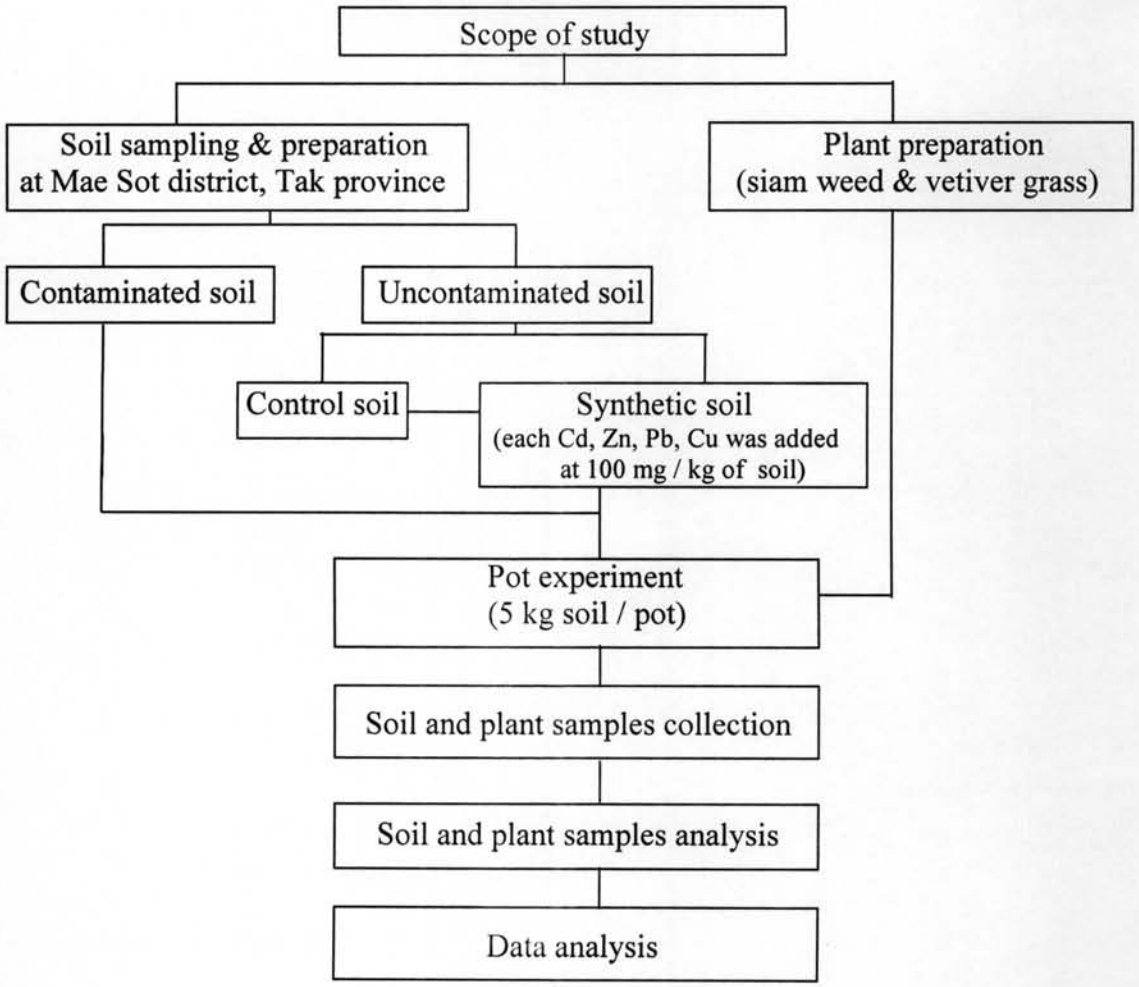

Figure 1.1 The Chart of overall experiment design