CHAPTER 1

Introduction

1.1 Background and Motivation

Ping River (also known as Mae Ping) is one of the main contributories of Chao Phraya River. It covers a third of the country's water resources *(Mapian, 2008)* and transports about 24% of the Chao Phraya River basin's total runoff *(Thomas, 2006).*The river is 658 km long and the basin of the entire Ping River system, including its tributary the Wang River, covers a total of 44,688 squares kilometers. The topography of the Ping River basin is characterized by various mountains and low-land valleys *(DWMO, World Bank).* The Ping River basin spans portions of 5 provinces: Chiang Mai, Lamphun, Tak, KamphaengPhet and Nakhonsawan*(gwp-sea,2008).* The hydrology of the Ping River is largely dictated by the natural seasonal patterns which consists of a dry and a rainy seasons *(Christie, 2014).*

The river is divided into two parts; the upper Ping which is located north of Bhumidol Dam in Chiang Mai Province, and the lower Ping to the south of the Dam *(Thomas, 2006).* The upper Ping River basin drains a catchment area of approximately 25,370 square kilometers and supplies the water resources of Chiang Mai and Lamphum provinces *(Wisuwat, 2010)* .Annual runoff and rainfall are around 6815 million cubic meters and 1174.1 mm, respectively *(Mapian, 2008)* . The Ping River is locally known as the "Lifeline of the Chiang Mai Province" (*Chiang Mai Magazine, 2008).*

Chiang Mai city, the second largest city in Thailand, is also the capital of Chiang Mai Province and is located in Thailand's northern region (*Lekuthai, 2008)* . The city extends area of 40.216 square kilometers and exists at 18º 47' 24.0" N, 98º 58' 37.2" E, and an altitude of 314 meters above sea level (*Christie, 2014).* In the past few decades, the city expands in every direction, especially, in the east of Ping River *(Wanchai, 1990)*. The total population in Chiang Mai province is 1.6 million, in the municipal area

is 234,244 with 1,537 density (people/km) in 2015 *(Statnews,2016)* .The city center of Chiang Mai is surrounded by a walled moat known as the Old City. The majority (80%) of the Chiang Mai residents earn a living through agriculture and agricultural related professions *(Lanna, 2015).* The second largest industry is tourism and its directly and indirectly related jobs *(Department of Tourism, 2014)* .

In Chiang Mai, the most important source of drinking water is surface water, Ping River (Margane, 1999). About 45 households out of 63 households primarily use public water in dry season and 39 households out of 55 households mainly use public water in rainy season *(Otaki, 2008).* It means approximately 70% of the total households in Chiang Mai have to depend upon Ping River for daily water consumption. From the data of *Numbeo(2016)* , water pollution index of Chiang Mai is 57.69 and shows moderate index in water pollution.

For over 700 years, the Mae Ping River has been a major source of water for Chiang Mai. Historically, the Mae Ping provided the people in and around Chiang Mai with water for washing, bathing, and irrigating their gardens and rice paddies; the river was also a source of food and was used for the transport of people and goods. At the turn of the century, it was estimated that more than a thousand boats moved along its course between Chiang Mai and Tak. Boats still ply its waters, although the number of boats has diminished greatly over the last century, and the river itself is shallower and less swift than formerly. Though physically less of a river than it was a hundred years ago, it still plays a vital role in the lives of thousands of Thais who live on its banks. (*Chiang Mai Magazine, 2008*).

Chiang Mai City News (2014) revealed that the upper Ping River was significantly polluted with high levels of water degradation coinciding with the rapid urban development in Chiang Mai Province. Domestic wastewater sewage as well as waste from commercial establishments, factories, and residential homes have caused havoc on the water quality of the Ping River. Littering and the improper disposal of garbage is also a major cause of pollution in the river. This trouble destroy the aquatic life in the Ping River. In order to balance aquatic ecology of Ping River, Chiang Mai Governor headed the event of releasing 3.4 million fishes into the Ping River on Chakriday (6th

April) in 2014. The main purpose of this event is to renovate natural resources surrounding the Ping River (*Panupong, 2014).*

Moreover, Loy-Krathong Festival, which is the one of the well-known festivals in Chiang Mai City, causes pollution of Ping River. Loy-Krathong means "the floating baskets on the water" and this festival is held along the Ping River bank by floating the decorated baskets on the Ping river surface. Krathongs (decorated baskets) are mostly made up of banana-stem traditionally and the modern Krathongs are made up of bread or Styrofoam. During the festival, banana or bread Krathongs are biodegraded or eaten by fishes in Ping river; however Styrofoams clot the waterway and pollute the river (*National Geographic, 2015*).

Another polluted source of Ping River in Chiang Mai municipality area is the Mae Kha canal that flows into the Ping River after carrying wastes of 22 city communities along on its runway (*City News, 2016*). Intensive researches and interviews demonstrated that water pollution, low water flow, uncoordinated organizations involvement, properties rights and society's neglect are major factors of Mae Kha canal for its transformation from functional and beautiful to unpleasant canal. As a result, Mae Kha was deserted in severe degradation and turning into an open sewage of the city *(Nuanla, 2016*). City News revealed that Mae Kha Canal flushed 5000 cubic meters of waste into the Ping River after heavy rain in February, 2016.

Ping River is suffering many problems like other rivers in Thailand. Due to a rapid population increase, water problems such as pollution, shortages, droughts and floods, water resources development and management have become an increasingly important issue in Thailand (*Sacha, Suwit, Ladawan and Surapool,2000*) . Among the available water resources, nearly one-third of its water is unsuitable for human consumption *(PCD,2007).*Furthermore, *JICA news (2014)*stated that increase in water demand and climate changes are threatening to cause land use changes. Many pollution occurred as a result of improper land use in the basin(PCD). The another problem of water resource management includes the unsystematic and outdated database as one of the facts slowing down the management plan *(SCWRM, 20012)* ."Water quality" of Rivers is stated as one of the factors in integrated water management plan*(Nitipan,DWR).*

For all above statements, the water quality monitoring and awareness of water quality situation become important to assure the good water quality status for aquatic ecosystem as well as for public health. In this study, the water quality monitoring is mainly carried out in Ping River. In addition to water quality monitoring, the land use along the river bank is investigated as a secondary tasks. Moreover, the water quality is described not only as concentration but also as loading profile that is flowing through each sampling point in an instantaneous time.

The study is aim to get updated data of water quality in Ping River which can serve as a help for establishing river management plan in the future. The results of the study are also expected to give an understanding on non-point source pollution in the rivers.

1.2 Research Objectives

The two main objectives of the research are as follows:

1. To determine the nutrient and organic pollution profiles of Ping River in Chiang Mai City area during different periods of time.

2. To investigate land use along the Ping River in Chiang Mai City area.

1.3 Scope of the Study

In order to meet the research objectives, the scope of the study was set up as follows:

1. The segment of Ping River ,which is passing through the Chiang Mai City, was selected as the study site. The study area started from upstream at Tambon San Phi Suea and ended at downstream at Pa Daet Village (where above about 2 km is the junction with Mae Kha Canal).

2. The water flow measurement was done by “velocity-area method”. The velocity of the stream was measured by “float method” and the measurement of cross-sectional area of the river was carried out by manual tape measurement.

3. The water samples were collected as “grab sample” using sampling tube from above the bridges, culverts or crossways located along the river. The samples were taken from the middle of the width of the river; about 25 cm beneath the river surface. Samples were collected at 5 different places in different seasonal period starting from October 2015 and ending at April 2016. The concentration of samples were covered all of three different seasons: late rainy season, cool dry season and early dry season.

4. The physical characteristics of samples such as pH, temperature of air and water, and electrical conductivity were measured on site by using appropriate meters for each parameter. Organic concentration measurements such as 5-day biological oxygen demand (BOD_5) and chemical oxygen demand (COD) were analyzed in the laboratory. And nutrient concentration measurements such as different species of nitrogen (including nitrite nitrogen, nitrate nitrogen, ammonia nitrogen and total Kjeldahl nitrogen (TKN)) and different phases of phosphorus (including orthophosphate and total phosphate) were also analyzed in the laboratory.

5. The pollution of profiles of Ping River were described as organic and nutrient loadings in kg/day. The loadings were calculated by the product of concentrations and flow rates for each samples. The organic loadings included BOD and COD, and nutrient loadings included total nitrogen (TN), dissolved inorganic nitrogen (DIN), total phosphate (TP) and soluble reactive phosphorus (SRP).

6. Land uses along the Ping River in the study area were investigated by site surveying and the sources of contaminants in the upstream of each sampling point were roughly categorized into different land utilizations such as agricultural, industrial, or domestic.