CHAPTER III

METHODOLOGY

In order to achieve the objectives of the study, the following procedures was conducted and a flow chart of the methodology is illustrated in Figure 3.1

3.1 Literature Review and Field Study

All basic data acquisition, library researches, and literature studies were firstly reviewed and evaluated for the area. After reviewing all available data, the field study was conducted. During the field study, data that can be obtained was generally being from a social point of view. For instance, villagers' opinions on cadmium concentrations uptake and deposit in the population body (from Tak hospital), villagers' way of life and land use management. Moreover, the topography of the area was reviewed.

3.2 Data Collection and Preparation

In this step, an existing data was collected and then imported to the Geographic Information System (GIS) using ArcView 3.3 and PCI Geomatica V9.1 software. Collected data can be divided into 2 main categories: a spatial data and an attribute data. A spatial data describes location related factors of an object or area whereas an attribute data is a characteristic of an object.

3.2.1 Spatial Data

According to the study, the spatial data which was collected and prepared are satellite images, Topographic Map, Geologic Map, Landuse Map and Mineral Resource Map. General information of each spatial data is described below and also summarized in Table3.1

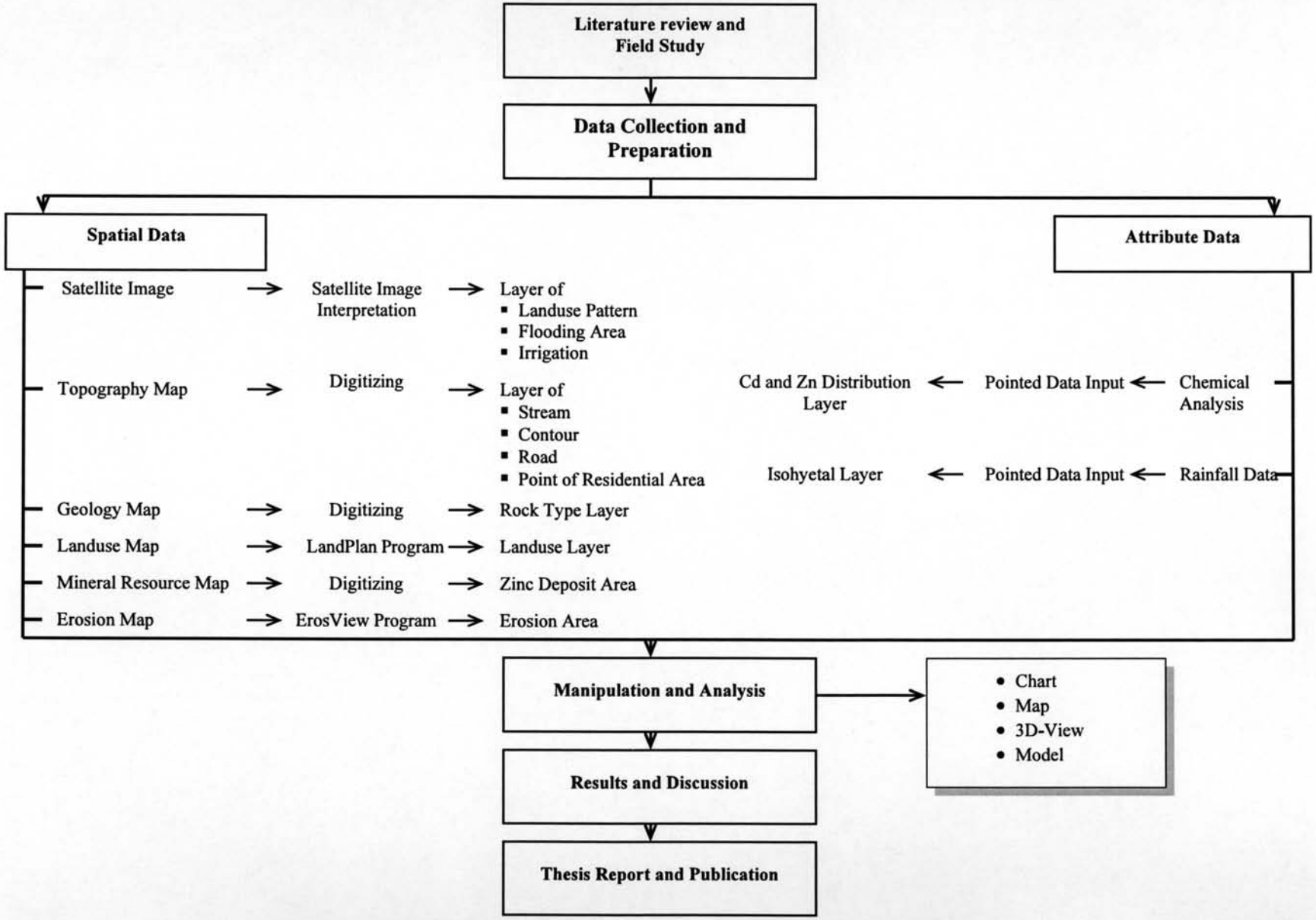

Figure 3.1 Schematic diagram showing of methodology and step of works under this study.

Table 3.1 Spatial data which were collected and prepared for analysis.

No.	Data	Description	Source of Data	Data Format	Note
1.	Satellite Image	3 satellite images of Landsat TM5 taken in the different time and 1 image of IKONOS are collected Satellite: Landsat TM5 Path/Row: 131/48 Date: 25/02/1988 13/03/1994 10/12/1994 Satellite: IKONOS Date: 04/02/2003	Geo-Informatics and Space Technology Development Agency (GISTDA)	SHP	Figure A-1 (a) Figure A-1 (b) Figure A-1 (c) Figure A-1 (d) Figure A-2
2.	Topographic Map	Map scale: 1:50,000 Series: L7017 Sheet: 4742III	Royal Thai Survey Department	JPEG	Figure A-3 (a)
		Map scale: 1:250,000 Sheet: 47-14	Royal Thai Survey Department	JPEG	Figure A-3 (b)
		Map created by combining several SHP file including: District.shp Tambon.shp Countour.shp Village.shp River.shp Road.shp	Created by ArcView 3.3	SHP	See also Figure 2.3

Table 3.1 (cont.) Spatial data which were collected and prepared for analysis.

No.	Data	Description	Source of Data	Data Format	Note
3.	Geologic Map	Map scale: 1:50,000 Sheet: 47-14	Department of Mineral Resources, DMR	JPEG	Figure A-4.
		Map created by combining District.shp and Geologic structure.shp	Created by ArcView 3.3	SHP	See also Figure 2.5
4.	Landuse Map	Two maps showing landuse of Mae Sot District, Tak Province in the different year (1984 and 2000) generated from LandPlan program	Land Development Department (LDD)	SHP	Figure A-5.
5.	Mineral Resource Map	Map scale: 1:250,000 Sheet: 47-14	DMR	JPEG	Figure A-6.
6.	Erosion Map	A map shows levels of erosion on Mae Sot District created by ErosView program	LDD	SHP	Figure A-7.

(1) Satellite Image: Satellite images which are used in this study consist of three digital images of Landsat TM5 and an IKONOS image obtained from Geo-Informatics and Space Technology Development Agency (GISTDA). The image of Landsat TM5 gives a resolution at 30 meter by 30 meter which is lower than those of IKONOS available high-resolution at 1 and 4 meter.

Three digital Landsat TM5 data sets of the 131-48 path and row covering the whole area of Mae Sot District were used in this study. They are taken on the different period of time. The first one taken on 25 February 1988 was interpreted for landuse change purpose. Meanwhile the others taken on 13 March 1994 and 10 December 1994 were interpreted for finding out the effect of rainfall and flooding on the study area and for landuse change purpose as well. All three Landsat TM5 images were interpreted using PCI Geomatica V9.1 software. Generally, the image processing can be categorized into a few basic steps. The first one is image restoration, the function that is normally grouped as radiometric or geometric corrections. Image enhancement is the second step which is method attempt to improve the quality of an image and also possible to increase the visibility of features at a certain scale. According to this study, bands 3, 4 and 5 were selected to create false color composite for interpretation because it provides more prominent image. Moreover using bands 3, 4 and 5 also clearly separates the different between soil and vegetable. Examples of meaning from this false color composite are vegetables presents in red color or water present in dark blue. The last step, image classification which means the operation to digitally identify and classify pixels in the data is finally performed. Unsupervised classification which means the computer selects natural groupings of pixels based on their spectral properties without any user-defined training classes was selected for this study. Moreover, the Landsat TM5 image taken on 10 December 1994 was used to identify zone of flooding by digitize technique using ArcView 3.3.

The satellite image of the IKNOS taken on 4 February 2003 was also interpreted. It dose not cover the whole area of Mae Sot but only the two main sub catchments; Huai Mae Tao and Huai Mae Ku. Due to its high resolution, it was used for more details on the focusing area especially in the section of cadmium and zinc distribution in soil and in stream sediment (3.3.3 and 3.3.4). For the interpretation, the

image was input to the GIS by ArcView 3.3 and then digitize for an irrigation system of the area.

(2) Topographic Map: A map which shows regional topography of the study area was generated by Arcview 3.3. It was conducted by overly several layers of data from the Land Development Department (LDD) includes contour, road, stream, district and sub-district boundary and village. The created-map was finally checked with two topographic maps of Royal Thai Survey Department. The first one presents in map scale of 1:50,000 while another one presents in map scale of 1:250,000.

(3) Geologic Map: It was operated by the same method with the topographic map. Data which were used for overly consisted of rock type, geologic structure, mining area and stream. It was checked with the geologic map of the Department of Mineral Resource (DMR).

(4) Landuse Map: Two landuse maps of Mae Sot District in the year of 1984 and 2000 were generated by LandPlan program which is developed by the LDD.

(5) Mineral Resource Map: This map is belonged to the DMR. It was imported to the GIS by ArcView 3.3 and then digitize for the zinc deposit area.

(6) Erosion Map: The erosion map was generated by the ErosView program which is developed by the LDD. This program uses the Revised Universal Soil Loss Equation; RUSLE for the calculation and classify the erosion area.

3.2.2 Attribute Data

The corrected attribute data in this study concluded of results of chemical analysis and rainfall data are described below and also shows in Table 3.2

(1) Results of Chemical Analysis: raw data that represent elements (Cd, Zn and Pb) contained in specimens, which means soil and stream sediment. Chemical analyses were conducted by several agencies and can be classified by the specimens. For cadmium and zinc distribution in soil, it was conducted by Janpho (2006) and National Research Center for Environmental and Hazardous Waste Management, NRC-EHWM (2005). Meanwhile, cadmium and zinc distribution in stream sediment was studied by Department of Primary Industries and Mines, DPIM (2006) and Maneewong (2006).

Table 3.2 Attribute data which were collected and prepared for analysis.

No.	Data	Description	Source of Data	Data Format	Note
1.	Results of Chemical Analysis	Results of chemical analysis present cadmium and zinc contain in soil and stream sediment conducted by many researchers.	Maneewong (2006) DPIM (2006) Junpho (2006) NRC-EHWM (2005)	dBAES	Table B-1 Table B-2 Table B-3
2.	Rainfall Data	The 21-year back rainfall data measured at 4 weather stations which are Mae Sot Station, Tak Station, Umphang Station, and Bhumibol Dam Station.	Thai Meteorological Department (TMD)	dBAES	Table B-4, B-5, B-6 and B-7

(2) Rainfall Data: The 21-year back rainfall data (1985 to 2006) measured at 4 weather stations around the Mae Sot District namely Mae Sot Station, Tak Station, Umphang Station and Bhumibol Dam Station are used in this study. The source of data is Thai Meteorological Department (TMD).

Both of two kinds of attribute data was recorded in an Excel program and then input into the GIS using ArcView 3.3 by converting them into a dBase file (a file which can be operated by the GIS) and finally convert them to be a spatial data.

3.3 Manipulation and Analysis

Since all collected data come from various sources, after importing them to the Geographic Information System, they need to be manipulated, which means, converting all data into the same scale and same geo-reference. Refer to the study; most of the data have been converted from UTM indian75 to UTM WGS84. After converting all data, the analyzing operations which can be classified into six steps were conducted.

3.3.1 Landuse Change

Two interpreted-images of Landsat TM5 taken on 25 February 1988 and 10 December 1994 were used in this step. In addition, two landuse maps of Mae Sot District in the year of 1984 and 2000 from the LDD were used as well. Comparing area (Rai) or % area of each landuse type to find out the changes of landuse from year 1984 to 2000 on Mae Sot District.

3.3.2 Effect of Rainfall and Flooding

The necessary data for this purpose is the 21-year back rainfall data getting from TMD. This data was imported to GIS program and then was converted to be a map showing an isohyetal line covering Mae Sot District and its adjacent area. In addition, from that data, 2 charts which present a mean annual rainfall amount

measured at Mae Sot Station from the year 1988 to 2005 and a mean of monthly rainfall amount measured at Mae Sot station were also generated. From the map and two charts, they could indicate area, time and level of flooding. Finally, to find out the effect of rainfall and flooding on the study area, the 2 interpreted-images of digital Landsat TM5 (taken on 13 March 1994 and 10 December 1994) were used to compare percent of each landuse type.

3.3.3 Cadmium and Zinc Distribution in Soil

Collecting data of chemical analysis in soil included the results of NRC-EHWM (2005) and Janpho (2006). The first one occupied the area of Huai Mae Tao and the last one was along Huai Mae Ku. Combining two groups of that data and then input them into a data base of GIS via ArcView 3.3 and then converted them to be a spatial data. After converting, analyzed the data by histogram and finally classified level of cadmium and zinc contaminated area.

3.3.4 Cadmium and Zinc Distribution in Stream Sediment

The operation in this step started with combining the data of chemical analysis in stream sediment conducted by Maneewong (2006) and DPIM (2006) which the sampling stations are along Mae Tao and Mae Ku creek. Then analyzed the data by histogram in order to find out cadmium and zinc distribution in stream sediment.

3.3.5 Erosion

The purpose of this step is to conclude the relationship between erosion area and other factor in the study area. It was done by overly the soil erosion layer of Mae Sot District created by the ErosView program of LDD with other layers such as river or stream, mining area, sub-catchments and landuse.

3.3.6 Potential Source of Contamination

From those analyzing steps, all output data consist of the classification of cadmium contaminated area, erosion area, mining area, stream, landuse, flooding area, sub-catchments and irrigation system were then combined and all significant relationships were identified in order to explain and give a clear picture on related resources in this study area. Subsequently, the analysis of all information was lead to the formulation and proposes of a well-managed plan for the rehabilitation of the study area.